SCIENCE

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MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

*THE CARNEGIE TECHNICAL SCHOOL.**

IT was the intention of your vice-president to prepare an address on the Evolution of the Mechanics of the Telescope for presentation before Section D of this Association, but a new and important theme has been brought before me by reason of intimate association therewith, and to which a number of the members of this Section have contributed most valuable data. I therefore beg to present to you a few notes upon this subject, namely, the technical school for which Mr. Andrew Carnegie has most generously proposed to furnish the means to build, equip and endow in the city of Pittsburg. When Mr. Carnegie gave to the city its library, its art gallery, its temple of music and its museum, neither the donor nor the citizens had the remotest dream of what they would develop into, nor how far their influence would reach and be felt. I need not tell you what potent factors these institutions have been as educators in the realms of art, science and literature. Suffice it to say, that every department of the great institute has proved itself worthy of its name and is doing marvelous work for the betterment of the people. So marked has been this development during the six years of the existence of the Pittsburg Institute that Mr. Carnegie has given over three million dollars to enlarge its boundaries and increase its influence.

But Mr. Carnegie had promised even greater things for the city of his adoption. He knew as well as any man the need, the great value of a school of technology in

* Address of the vice-president and chairman of Section D, Mechanical Science and Engineering, of the American Association for the Advancement of Science, Denver meeting, August, 1901.

Pennsylvania's great hive of industry; and with but little preliminary discussion of the subject, with full confidence in the commission that had been entrusted with the building, care and development of the Pittsburg Institute, he proposed to furnish the means to build, equip and endow a school of technology on the broadest possible basis, whose doors should be open not only to students from western Pennsylvania, but eventually to students from any part of the world.

President Frew of the Carnegie Commission appointed two committees: (A) A committee to confer with the city officials in reference to a site for the building, etc. (B) A committee on 'Plan and Scope' of the proposed technical school. On this latter committee President Frew appointed the following gentlemen:

President Wm. McConway, of the McConway, Torley Manufacturing Co.; Chas. M. Schwab, president Carnegie Steel Co.; Wm. A. Magee, 'Times Publishing Co.'; Hon. Wm. A. Diehl, Mayor of Pittsburg, and John A. Brashear.

After a series of important meetings in which the best plan of procedure was carefully discussed, Mr. Schwab found it necessary to resign as a member of the committee, as he had been called to the position of president of the United States Steel Co. The resignation of Mr. Schwab was greatly regretted, as he has had large personal experience in technical and manual training schools, having built and endowed a splendid school in Homestead, Pennsylvania, in the very center of the great steel industries. Mr. W. Lucien Scaife was appointed to fill the place made vacant by the resignation of Mr. Schwab. He is a graduate of the Sheffield Scientific School and has studied in the technical schools of France and Germany, and his technical and practical knowledge has proved of great value in the deliberations of the committee.

After a careful discussion of the plan of procedure it was decided to call to our assistance a number of the best men on technical lines in the country, rather than one man, no matter how thoroughly he might be posted in technical school matters, for the one man might have a bias, either of education or environment, which, while it possibly would be in the direction of the very best plan and scope for the new school, might be detrimental to its highest development; and in this important matter it was concluded that in the 'multitude of counsellors' there ought to be wisdom. The committee therefore called to its assistance, Dr. Robert H. Thurston, Professor J. B. Johnson, Dr. Thomas Gray (all members of Section D of the Association) and Dr. Victor Alderson, acting president of the Armour Institute of Chicago. These gentlemen were to come to Pittsburg last spring to study the conditions and environment which would necessarily be important factors in formulating the plan and scope of the new school and, after several pleasant meetings with our own committee, arranged to return to Pittsburg on the 24th of June to make at least a preliminary, if not comprehensive and final report. In the meantime the original committee found much work to do, for communications were coming from eminent technologists, technological societies, domestic art associations, educators in manual training schools and mechanical engineers, all of which contained much good grain, with here and there a hobbyist whose theories were mixed with a good deal of chaff; but on the whole we found a widespread interest in the development of what, let us hope, will eventually become one of the best institutions for technical instruction in this good land of ours. It is for the purpose of leading the members of this Section of the American Association to take an interest in the new school, that this paper is written. It contains no new

thought, no new theories, but calls for your help in a project which we believe will be for the betterment of a large class of students, whose means are necessarily limited, but who will be, let us profoundly hope, mighty factors in the future development of American technological and allied industries.

If we are to keep fast hold of the prestige we have gained in the industrial world by hard work and persistent effort, we must open the storehouse of knowledge to our future mechanicians, engineers, etc., give them an opportunity to partake of the treasures stored therein, and we shall have no fear of the position we are to occupy in the coming years.

Our advisory committee, having studied the problem from many points of view, met with us in Pittsburg on the twenty-fourth of June last, each member having formulated his plans without consultation with other members of the committee, yet it is a matter of interest to know that the expressed views of the advisory board as individual members were so nearly in accord on the general principles formulated for the great school of technology. Of course with such a field to work upon, there were a number of most valuable suggestions made by the individual members of the board, all of which will be of use to our committee in making up its report to the commission.

With your permission, and I am sure with that of the several members of the advisory board, I will give as briefly as possible an outline of the scheme for the new technical school.

First, as to site. The Carnegie Institute is situated in Schenley Park; and it was thought desirable by Mr. Carnegie and members of the commission to secure, if possible, enough ground near the Institute for the technical school. A tract of eleven acres was the only available land in the Park, but this was at once pronounced far too limited in extent for the new school; indeed the first plan of buildings, campus, etc., submitted by Mr. Emil Swensson, of the Carnegie Steel Co., covered 40 acres and this for not more than one thousand students. The advisory board suggested that not less than 50 acres be secured, and as a tract of 65 acres is available not far distant from the Carnegie Institute, the board strongly recommended its purchase, or a similar piece of land as near by as it is possible to obtain it. A potent reason for placing the technical school near the Carnegie Institute is the fact that its library is rich in technical and other valuable works, which need not be duplicated in the technical school library; indeed the association of the school with the great and increasingly valuable library, museum, art gallery and Academy of Science and Art is certainly to be desired. In this connection it may be well to state that it was the intention of the donor that the city should furnish the land upon which the school of technology should be built, but it is the unanimous opinion of the advisory board that, as Mr. Carnegie not only proposes to build and equip but fully to endow it, it would be far better to purchase the land and thus, while bringing to the city of Pittsburg all the honor such a school of technology would bring, keep it forever free from baneful political influences. Dr. Gray says in summing up his report: "Such an institution properly managed, could in my opinion do much more to advance the science which underlies our industries than any national or State institution is ever likely to do, hampered as all of them are by political association. I may in conclusion express the opinion that for the best work, independence of city or other politics should if possible be insured by avoiding all kinds of public financial support."

As to the buildings for the technical school but little has been suggested; indeed,

this part of the problem, important as it is, may well be left open until the 'scope' of the great work to be done is well in hand. Dr. Thurston in his report has given an interesting résumé of the space occupied by the student in the various German technical schools, remarking that the German motto 'Viel Platz, Viel Licht, Viel Luft,' would be an excellent guide in determining this question. He says: "Ample space, good light and plenty of fresh air are essential, although the architect who should be the most earnest and intelligent of them all is often woefully deficient in appreciation of their importance when brain work is going on." Dr. Thurston further states that taking figures from the best German technical schools, which are based on the largest experience, the school of architecture at Berlin has 150 feet floor space per student, the engineering school 35 feet, but this latter school is so much over-crowded that arrangements are being made to give the student in this department at least 75 feet of floor space. In marine engineering 111 feet are provided and in metallurgy and the chemical departments each student has 426 square feet of space. Professor Thurston advises not less than 30 square feet per student in class rooms, in drawing rooms about 100 and in laboratories from 150 to 500 feet, according to character of the work to be done and magnitude of the space required for machinery and apparatus.

The Brunswick school has 410 feet floor space per student in all departments. At Karlsruhe 450 square feet is provided in the department of electrotechnics. The cost of the Berlin building is placed at $1,000 per student, of the Brunswick buildings $2,000 per student. From this data it can be seen that an institution which may be called upon to provide for a thousand students at once, and perhaps three or four times that number in the near future, must be planned upon a most liberal scale to meet the demands which will be made upon it, and here we shall be confronted with the cost of such buildings. With the knowledge that Mr. Carnegie would not be satisfied with buildings devoid of architectural beauty, I feel morally certain that he would not be willing to invest his millions in buildings not properly constructed for the specific purpose for which they are intended, and with all regard to the society of architects, it is to be hoped that utility will be the first question solved in this important undertaking.

In a recent communication from Dr. Barker, of the University of Pennsylvania, upon this subject he says: "I hope the mistake will not be made of spending too much money upon buildings. The order of expenditure should be as follows: (*a*) Instruction; (*b*) endowment; (*c*) equipment; (*d*) building; by this I mean that the securing of the very best ability in the men in all the departments is an absolute desideratum, not only as teachers but investigators, for technical science is advancing so rapidly that abstract research in pure science cannot keep up with it and so applied science has to enter upon research work to supply the data it needs.

"Next comes endowment. In far too many cases, all the money given has been expended upon building and equipment, leaving nothing for maintenance." Dr. Barker then refers to a number of our noted American universities which have splendid buildings and some of them fine equipment, but with little or no funds to carry on research work. The members of this Association know this fact too well, many of them from unpleasant personal experience. Shall we steer clear of these shoals in the new technical schools?

Brainy men do not need a palace in which to make discoveries. Place a Newton, a Napier, a Faraday or an Edison, a Watt or an Ericson in a hovel and the discoveries

will come whether we will or not. Fortunately we are assured that the man who has given this great technical school for the glorious purpose it is sure to subserve will see to it that the endowment does not suffer, even if the buildings are constructed on a generous scale, but I know it to be his desire that the best technological knowledge shall be united with architectural design, so that the buildings may combine utility with beauty and reflect honor on all associated with the work.

And now as to the scope of the new school. That American schools of technology have done magnificent work for two or three decades goes without saying. Shall the new schools follow in the footsteps of the best of them, shall it unite the best features of one school with the best of another, or shall it venture upon entirely new fields to push outward the borders of human knowledge? The American, German, English, French and Swiss schools have been studied by the members of the advisory board (as well as by some members of our committee), and we have been greatly helped in formulating our plans of what the new school should be, by the generous data given in their report.

A summary of Professor Johnson's proposed scheme for the Carnegie School of Technology is as follows:

A. Colleges. Courses of four years with a high school preparation.

1. College of Science.
2. College of Engineering.
3. College of Commerce.

All the above of university grade, with degrees conferred at graduation.

B. Schools. Courses three years with a grammar school preparation.

1. Manual Training School.
2. Domestic Science School.
3. School of Industrial Design.
4. School of Commerce.

All the above of high school grade. Diplomas given at graduation.

C. Artisan Day School. Courses of three years with a preparation in reading, writing and arithmetic.

To include courses of instruction in subjects of essential importance in the practice of the various trades.

D. Night School for day workers. Preparation same as C.

Regular courses, and also special instructions of practical value to day workers of all sorts and all employments.

Professor Johnson, Dr. Alderson and Dr. Gray studied a number of the industries of our city, and in all their reports they emphasized the value of the secondary schools. The question of monotechnic or trade schools, *i. e.*, where a young man or woman can learn at least the rudiments of the trade by which they propose to make their living, was also discussed by Professor Johnson and Dr. Alderson with the writer, and it is the opinion of both committee and advisory board that in due time this part of the problem should be given earnest consideration. A summary of Dr. Alderson's recommendations as to the various departments that could advantageously be established in the school are:

First—Department of Engineering, comprising

(*a*) Mechanical Engineering.
(*b*) Electrical Engineering.
(*c*) Civil Engineering.
(*d*) Chemical Engineering.
(*e*) Electro-chemical Engineering.
(*f*) Foundry Practice.
(*g*) Metallurgy (iron and steel).

Second—Department of Secondary Education.

1. Work preparatory to the College of Engineering.
2. Secondary Technical Education.

Courses in

(*a*) Machine Tool Work.
(*b*) Stationary Engineering.
(*c*) Elementary Electrical Engineering.
(*d*) Elementary Mechanical Engineering.
(*e*) Foundry Practice.
(*f*) Surveying.
(*g*) Drafting.
(*h*) Machine Design.
(*i*) Glass Making.
(*j*) Blacksmithing.
(*k*) Pattern Making.

(*l*) Brass Making.

3. Department of Library Economy.

4. Department of Domestic Arts and Sciences.

(*a*) Normal Course.

(*b*) Courses in cooking, sewing, dressmaking, millinery and household economy.

5. Department of Art.

6. Department of Evening Instruction.

Dr. Alderson closes his summary with these words of sterling advice: "The Carnegie School of Technology should be a protest against *surface education;* it should educate the hand and eye as well as the mind; it should emphasize the *doing* element in education; it should be essentially a school of applied sciences; and finally it should enter the broad field of technical education, supplying useful knowledge to boys and girls, young men and young women. The Carnegie School of Technology, located in a center of industrial activity, on grounds naturally beautiful and attractive, carefully planned and thoughtfully administered, can be made to bear the same relation to the great work of technical education that Columbia College does to university education, and thus become a technical school second to none.

Dr. Gray recommends that the institute should offer a course of instruction covering the whole nine years of study; that it be divided into two distinct schools, a secondary and upper secondary, and a higher college or professional school. He advises that the secondary school commence above the grade schools with a minimum age limit of 14 years, and that the course of instruction should include all the subjects commonly given in the best high schools, with the possible exception of Latin and Greek, and in addition the subjects more commonly given in business schools or colleges; along with this course of class room instruction, provision should be made for practical instruction, either manual or otherwise, bearing upon the particular branch of industry which the scholar intends to enter. The duration of this course should be about four years, as at present in city schools, but should be freed from a number of subjects that are of little use to the ordinary artisan class. Dr. Gray recommends a good sound course in English for students of the secondary school, but does not recommend a study of foreign languages.

One of the most important, if not the most important, recommendations made by Dr. Gray is that in regard to the upper school. I quote his language:

"This school can be made to fill the place which the present technical colleges have failed to do, namely, provide a college education for men of the rank of shop foremen, superintendents, etc. In this course, which should be of two years' duration, instruction can be given in such subjects as the design of structures and machinery, the properties of materials and machines, the design and management of power stations, telegraphy, and train signal systems, the surveying and construction of railway beds, civil engineer's and architect's office work, finer kinds of machine work and a host of other subjects, the understanding being that these subjects be treated in such a manner that *practical* information shall be the object rather than fundamental mathematical principles."

Other matters of importance are suggested in this part of Dr. Gray's report, one of which is that as there would probably be those in this course who would find it impossible to take the higher or technical college education, this upper secondary school would serve as a most excellent preparation for the same.

Dr. Gray recommends that the technical college or professional school be open only to a selected small number of students who have shown special fitness for the work, and that the entrance requirements should be considerably higher than is usual in existing

technical colleges. For this department extensive laboratory practice is recommended and thorough drill in the methods of testing properties of matter and in investigational work. Dr. Gray—as indeed every member of the advisory board—thoroughly agrees with Dr. Barker that apparatus should not be merely toys, that they must subserve some real purpose in the activities of life. As Dr. Barker puts it: "Where shall we draw the line between a testing machine and a cohesion apparatus—between a calorimeter of a pint capacity (an apparatus) and one of 100 gallons (a machine)," etc.

Dr. Gray suggests that this course might be of three years' duration and that fees be charged. Deserving students unable to bear the expense could possibly be provided with scholarships. Original research should be a prominent feature in this higher college.

Dr. Thurston's report to the committee is an exhaustive one, covering every phase of technical education, and as the commission will have it printed in full with the reports of other members of the board, I shall only give a few of the salient points in his paper.

Dr. Thurston assumes that the purpose of the institute will be primarily the useful education and technical training of the young people of Pittsburg, and especially of those belonging to the great body of wage earners, and that both sexes are, if practicable, to be equally well cared for. He divides these into two classes: (*a*) Those who can come to the instructor and give their time as required to study, to lectures and to recitations, and (*b*) those who are compelled to work during the working hours of the establishments in which they are employed and can only be given instruction outside during the evening hours, usually in evening classes.

Dr. Thurston asks: "Is it practicable to carry into effect that ambition of every technical education, so admirably pictured by Scott Russell, 'the Technical University on the lines of which Ezra Cornell would have approved, where any man could secure instruction in any study in such departments as are capable of being utilized practicably in the sequel of life. It is obvious that could such an institution be founded, and thus the noble example be furnished in full perfection, and a standard thus provided by which to measure, the establishment of this complete and perfect model would, very probably, advance the cause of useful education of the people, for the life and work of the people for many years. It is possible that the opportunity is here and now presented, and that, lost, it may not recur again.'"

The opportunity is one not simply to provide education of the most imperatively needed sort for the youth of Pittsburg, but it is an opportunity to establish a model of the most perfect and most widely useful institution of learning that has been conceived, and that shall, by force of example establish a standard and promote the most complete and perfect system of technical and liberal education anywhere.

The general scheme laid out for the great technical school by Dr. Thurston is as follows:

(*a*) The college of mechanical engineering and the mechanic arts, with eight different departments of mechanical engineering.

(*b*) The college of civil engineering—with six departments.

(*c*) The college of architecture with three departments.

(*d*) The college of mines and metallurgy with two departments.

(*e*) The college of agriculture with six departments.

(*f*) The college of applied chemistry with four departments.

(*g*) The college of physics with two departments.

(*h*) The college of fine arts with three departments.

(*i*) The college of the business man with four departments.

(*j*) The college of navigation and marine transportation with two departments.

(*k*) The college of mathematics with two departments.

(*l*) The college of politics and economics with four departments.

(*m*) The college of languages and literature with four departments.

(*n*) The college of philosophical science and ethics.

(*o*) The college of biology.

(*p*) The preparatory college (standard curriculum).

"This scheme appears an ambitious one, but it so appears simply because we are in the very inception of educational work, and few persons have the slightest idea of the need or the opportunity for promoting the highest interests of the nation through a thoroughly systematized education."

Dr. Thurston refers with just pride to the Massachusetts Institute of Technology, the Armour Institute, the Pratt and Drexel institutes, as well as to others of a similar character, giving the curriculum of that sterling school of technology, the Massachusetts Institute, as well as much valuable data regarding the faculty, equipments and graduate students, all of which is compared with the Royal Technical College at Berlin. Dr. Thurston, with every other member of the commission, lays particular stress upon the value of the secondary school which he chooses to call the technical high school and which it is evident will meet the needs of the largest number of people. He chooses for a typical illustration of this division of the scheme the splendid work of the Pratt Institute of Brooklyn. Dr. Thurston also emphasizes the great value of such a secondary school to the young men and women of Pittsburg particularly, and believes it is only carrying out Mr. Carnegie's wishes to develop this department to its fullest extent.

As to the higher departments of the new school he expresses himself most charmingly in the language of John Russell on the occasion of the latter's visit to a German technical university: "A technical university abroad was to me a surprise, a profound lesson, a delight. It was a dream of my youth suddenly embodied in living substance, and, unlike other realized dreams, the reality excelled the fiction. It was one of my early dreams that highly educated men should engage in teaching skilled workmen the profound philosophical principles which underlie all material work, and I hoped so to make their work their pleasure, excellence their ultimate aim and truth of execution and perfection of finish their highest ambition."

Dr. Thurston proceeds to discuss the higher branch of technical education with special reference to the needs of Pittsburg, then gives us some valuable information as to the status of the faculty of the great school, quoting precedents in home and foreign institutions. Endowments are also discussed with a freedom that has opened our eyes to the vital importance of this part of the scheme, and to which I have already referred in this paper. Summarizing, Dr. Thurston says:

"The first step considered advisable in preparing to supply Pittsburg and its environs with an institution of high efficiency for technical instruction should be to make a plan of that final educational structure which is taken to represent the limit toward which progress is expected to advance. The actual construction of the scheme should be commenced with the most essential elements; the less immediately and imperatively needed parts should be arranged for later. In the present case it would probably be justifiable to assume that the aim of the school should be, first, to provide for the young people of Pittsburg needing elementary technical educational instruction, and to organize for this purpose a technical high school with evening classes for pupils unable to attend regularly the day classes. This foundation being laid,

the various developments which have been considered in the preceding pages may be added, each as the preceding element is completed, working continually toward the technical university and the highest ultimate divisions of the scheme, the department of experimental engineering and research.

"The method of organization would be that which best insures the management of the whole of the great scheme and of each of its subdivisions by men expert each in his own field, whether that of director of the technical university, principal of one of its schools, or professor or instructor, or workman in shop, drawing-room or laboratory. Such an organization of a staff of experts being provided, the administration will be certain to work smoothly and efficiently, without special attention to detail on the part of the trustees. Their largest problem will be the matter of securing the endowment and its income from deterioration in later years and consequent impediment or interruption of the enterprise.

"Every division of the institution, from lowest to highest and first to last, should be so planned as to work in concert with the public schools of similar grade as far as practicable. The technical high school might accept certificates from the academic high schools of the city and from other academies of similar rank; the pupils of the city schools might be given admission to the classes of the technical school in the shops and technical departments; a half-time school, as advocated by Professor Higgins, of Worcester, might possibly come of such mutual aid of city and technical schools. The technical school would be able, in some cases probably, to promote the initiation of special instruction in manual training and in the kindergarten forms of technical work in the public schools. Every possible means of allying the technical and the common school work should be availed of, and the cardinal principle should be constantly proclaimed and enforced: the purpose of the whole movement is to advance the best interests of the people of Pittsburg and its vicinity. It should be made distinctly understood that it is desired to make use of all possible ways to that end and to cooperate with every other educational movement."

In closing this far too lengthy paper I must acknowledge the great interest taken in the development of the scheme for the new technical school by the Engineers' Society of Western Pennsylvania, by the Women's Domestic Arts Association and by a number of eminent engineers, physicists and technologists at home and abroad; and the sole purpose of my paper is to ask the further cooperation and kindly advice of the members of this Association in formulating our plans, in steering clear of 'derelicts' and in making the Pittsburg Carnegie School of Technology what its generous patron wishes it to be and what the demands of this great industrial nation require it to be. Any communication sent Mr. Wm. McConway, chairman of our committee, Pittsburg, Pa., will be received and acknowledged with great pleasure.

J. A. BRASHEAR.

SECTION A (MATHEMATICS AND ASTRONOMY) OF THE AMERICAN ASSOCIATION.

THE officers of this section were: vice-president, James McMahon; secretary, G. A. Miller; councilor, G. B. Halsted; sectional committee, James McMahon, G. A. Miller, H. A. Howe, Florian Cajori, F. H. Loud; member of the general committee, C. A. Waldo. The meetings of the section were well attended and most of the papers aroused discussion. With the exception of the anniversary meeting at Boston, the program was the most extensive in the recent history of this section. It consisted of the following twenty-five papers. As

the last six are of special interest to section B, they were presented at a joint session of sections A and B.

'Supplementary Report on Non-Euclidean Geometry': Professor G. B. HALSTED, University of Texas.

This is a supplement to the report read at the Columbus meeting. It will be published in SCIENCE.

'Kepler's Problem for High Planetary Eccentricities': Professor H. A. HOWE, University of Denver.

The solution of the equation $M = E - e \sin E$ is commonly called Kepler's problem. The known quantities e and M are respectively the eccentricity and the mean anomaly. E is to be found.

The purpose of this paper is to develop a direct method of solving Kepler's problem for planetary orbits of high eccentricity, which shall be more expeditious than any heretofore discovered, and shall be sufficiently accurate to meet the most exacting requirements of astronomers. This method is an outgrowth of one published by the author several years ago.

Let E' be an approximate value of E found by the well-known equation

$$\tan (E' - \tfrac{1}{2}M) = \frac{1+e}{1-e} \tan \tfrac{1}{2}M. \qquad (1)$$

Let $2\eta = E' - M - \sin (E' - M)$, and

$$2\epsilon = \tfrac{1}{2}(E' - E) - \sin \tfrac{1}{2}(E' - E).$$

Then

$$E' - E = \frac{2\eta}{1 - e \cos \frac{1}{2}(E' + E)} - \frac{e \cos \frac{1}{2}(E' + E)}{1 - e \cos \frac{1}{2}(E' + E)} 4\epsilon. \qquad (2)$$

But the unknowns, E and 4ϵ, are in equation (2), and must be made to disappear. In the most eccentric of the asteroid-orbits the value of the last term of equation (2) does not reach 0.″0006; this term is therefore rejected, and we write with sufficient accuracy

$$E' - E = \frac{2\eta}{1 - e \cos \left\{ E' - \dfrac{\eta}{1 - e \cos (E' - \eta)} \right\}}. \qquad (3)$$

E' may be found from (1), and $E' - E$ from (3); then $E' - (E' - E) = E$, the quantity desired. The paper was illustrated by large charts and will be published in the *Astronomical Journal.*

'The Great Fireball of December 7, 1900': Professor H. A. HOWE and Miss L. L. STINGLEY.

On December 7, 1900, at about 3:20 p.m., mountain time, there passed over the northwestern quarter of Colorado a magnificent fireball, which exploded with startling detonations in the vicinity of the Bow Range near the north boundary-line of the state. The director of the Chamberlin Observatory prepared circulars of inquiry, containing a number of questions, which were lavishly distributed over the region from which the meteor was visible. The local press was also largely utilized for a dissemination of the queries. About 150 letters came in reply. Miss Stingley, of the class of 1903 in the College of Liberal Arts of the University of Denver, made a digest of these letters, and determined the meteor's path across the state. It passed nearly through the zenith of La Salle, and the main body came to earth in the vicinity of the town of Pearl. Its distance from the earth's surface, when near La Salle, was about 25 miles, and about 12 miles at the time of bursting. When the fireball was near Pearl an observation made by Mr. Thomas, of Manassa, a civil engineer, who was 250 miles away, gave it a height of 7 miles. Mr. Godshall, manager of a copper mining company, who was in Wyoming, about 40 miles beyond Pearl, saw the body come down in a curve somewhere in the general direction of Pearl.

Several observers thought that they saw fragments fall before the meteor reached Pearl, but on account of the wildness of the country none of the pieces have yet been found, though they have been searched for. The orbit has been computed on the

usual hypothesis that the path is a parabola. The body was moving nearly in the plane of the ecliptic, and caught up with the earth, which was traveling less rapidly in the same general direction. The search for fragments will continue. The paper will be illustrated by a large map showing the meteor's path across the country, and by a drawing exhibiting the relation of its orbit to that of the earth. It will be published in *Popular Astronomy*.

'Divergent and Conditionally Convergent Series whose Product is Absolutely Convergent': Professor F. CAJORI, Colorado College.

In an article on 'Divergent and Conditionally Convergent Series whose Product is Absolutely Convergent,' in the *Trans. of the Am. Math. Soc.*, Vol. II., pp. 25–36, were given special cases in which an absolutely convergent series is obtained as a result of multiplying two conditionally convergent series together, or one conditionally convergent series by a divergent series. But the sum of one of the two factor-series of each pair given in that article is zero. In the present paper it is shown that this is not a necessary property of conditionally convergent series whose product is absolutely convergent, and that the nth sum of such series may be of the degree $-r$, with respect to n, where $\frac{1}{2} < r \overline{\overline{<}} 1$.

'The Application of the Fundamental Laws of Algebra to the Multiplication of Infinite Series': F. CAJORI.

The behavior of infinite series with respect to the laws of algebra may be considered under two heads: An inquiry into the validity of the laws; (1) when applied to the *terms* of an infinite series; (2) when applied to the infinite series *themselves*.

The second inquiry, when made for the multiplication of series, leads to the conclusion that in this operation (assuming Cauchy's definition for the product of two infinite series), the associative, commutative, and distributive laws are obeyed.

The two series obtained by removing the parentheses from the series,

$$S_1 \equiv \sum_{p=0}^{p=\infty} \left(\frac{1}{4p^r+1} - \frac{1}{4p^r+4} + \frac{1}{4p^r+1} - \frac{1}{4p^r+4} \right),$$

$$S_2 \equiv \sum_{p=0}^{p=\infty} \left(\frac{1}{4p^r+4} + \frac{1}{4p^r+4} - \frac{1}{4p^r+1} - \frac{1}{4p^r+1} \right),$$

where $\frac{1}{2} < r \overline{\overline{<}} 1$, are conditionally convergent, but their product is absolutely convergent.

Hence,

$$(S_1S_2)(S_1S_2)(S_1S_2) \text{ is abs. convergent.}$$

But

$$(S_1S_2)(S_1S_2)(S_1S_2) = S_1^3 \cdot S_2^3, \text{ and}$$

S_1^3 and S_2^3 are each divergent when $r < \frac{2}{3}$. Hence, when $\frac{1}{2} < r < \frac{2}{3}$, S_1^3 and S_2^3 are two divergent series whose product is absolutely convergent.

'On Systems of Isothermal Curves': Professor L. E. DICKSON, University of Chicago.

The object of this paper is to give an elementary geometrical definition of a system of isothermal curves in the plane. The definition is readily extended to families of curves on any algebraic surface. Two families of curves are discussed at length. From these the general definition is apparent.

'The Plane Geometry of the Point in Space of Four Dimensions': C. J. KEYSER, Columbia University.

The space under investigation is the *point* (in 4-space) regarded as the assemblage of all the lineoids (*i. e.*, ordinary 3-fold spaces), planes and lines containing it. This space is 3-dimensional in lineoids and in lines, the lineoid and the line being reciprocal elements; it is 4-dimensional in planes, the plane being *self-reciprocal*. The plane being

taken as element, a theory results which is in its analytical aspect identical with the Plücker line theory of the lineoid, while the two theories are geometrically disparate. It is seen that, while neither of these geometries has a correlate in its own domain, each is in the domain of 4-space the perfect correlative of the other. Naturally, therefore, in the geometry of 4-space, whether it be the point-lineoid theory or the line-plane theory, the two doctrines in question play indispensable and precisely coordinate rôles. The subject is treated under the following six headings: Introductory considerations, concerning certain metric relationships, homogeneous coordinates of the plane, the linear complex plane, linear congruences of planes, projective transformations by means of complexes.

'The Next Opposition of Eros': Professor H. A. Howe and Miss M. C. Traylor.

The planet Eros, to which astronomers have recently given so much attention, is now too near the sun for observation. As it is evident that the observatories near the equator will have a better chance to rediscover the planet than those in the United States, computations have been made for Manila, where the Jesuit Fathers have a large telescope, and for Arequipa, Peru, where the Bruce 24-inch star camera is stationed. To represent the United States Denver has been chosen, its latitude being 39° 41′. For each of the three dates, May 1, June 1 and July 1 of 1902 have been computed the times of sunrise, of the beginning of the morning twilight, and of the rising of Eros. From these computations it appears that the conditions for early rediscovery are most favorable at Arequipa, excellent at Manila, and unpropitious at Denver. But before July 1 it should certainly have been observed in the United States.

In order to have a secure basis for a theory about the causes of the planet's variability, it is suggested that a table of standard magnitudes be computed for the entire period of visibility (May, 1902–October, 1903), on the assumption that the changes of brightness depend only on the relative positions of the sun, the earth and Eros. A comparison of the measured magnitudes with these will give data for theorizing.

A chart giving the path of Eros through the sky was exhibited, and also a pasteboard model of the orbits of the earth and the planet, showing their positions at favorable oppositions. This paper will appear in *Popular Astronomy*.

'On the Dimensions, Masses and Densities of the Satellites': Professor T. J. J. See, U. S. Naval Observatory.

The author points out the difficulty of measuring the angular diameters of very small bodies, on account of the tremors of the atmosphere, and then takes up the densities of the great planets as found in his recent investigations. He concludes that the average density of the four inner planets is 4.25, that of the outer planets 1.50. It is mentioned that the smaller inner planets have less density than the larger because the matter is less compressed by the action of gravity.

He then considers the diameters of the four large satellities of Jupiter; and, after analyzing the masses found by various investigators since the days of Laplace, adopts finally the masses used by Professor J. C. Adams. These masses, with the author's diameters, lead to the following densities for the several satellites:

Satellite I.	2.80	(Water = 1.)
Satellite II.	3.57	
Satellite III.	2.62	
Satellite IV.	0.76	

An investigation of Titan, the largest satellite of Saturn, shows its probable mass to be $\frac{1}{4700}$ that of Saturn, and the density 2.03. Thus Titan appears to be solid, and

less dense than the planet Mercury (3.00), which is the rarest of the inner planets. Professor See concludes that on the average the satellites are of the density 2.36, about the same as the matter which compresses the crust of the earth (2.55) ; and that the small satellites which cannot be measured are of about the same density as those which can be investigated, such as the four satellites of Jupiter, and Titan, the largest satellite of Saturn.

'Photometric Observations of Eros': HENRY M. PARKHURST, New York City.

These observations, extending from September 13 to March 22, comprised 382 double extinctions, in comparison with a large number of standard stars, including four other asteroids. From these observations the constant of brightness, reducing the distances to unity, was ascertained to be 9.78 mag., and the constant factor for phase angle .037. The phase correction, additional to the correction for defect of illuminated surface, was found to be uniform through the whole variation up to 58°. The observations confirm the discovery of the rapid change of brightness, undoubtedly due to rotation. The author's conclusion is that this change is probably due to the spheroidal form of Eros, the amount of the change depending upon the direction of the axis of rotation with regard to the earth.

'On the History of Several Fundamental Theorems in the Theory of Groups of Finite Order': DR. G. A. MILLER, Cornell University.

This paper will appear in a future number of SCIENCE.

'On Certain Methods in the Geometry of Position': Professor ARNOLD EMCH, University of Colorado.

In this paper the author attempts to outline those methods which seem to be best adapted for an introductory study of projective geometry. Particular stress is laid upon the study of homology in advanced plane geometry and descriptive geometry. It is shown that the principles of homology result naturally from the orthographic and also central projection, and that their application is conversely the best means for the construction of projective figures.

'The Parallaxes of 54 Piscium and Weisse 17^h, 322': Professor F. L. CHASE, Yale Observatory.

This paper was supplementary to a paper read by the same author before this section a year ago under the title, 'The Series of Parallaxes of Large Proper Motion Stars made with the Yale Heliometer,' a research begun in 1892, the observational part of which was finished the present year. In that paper the author had stated that the results of a preliminary solution indicated two of the 97 stars under investigation to possess a parallax of nearly 0".25, which values, if confirmed by further observation, would place them among the first ten or twelve nearest stars so far as at present known. These two stars have been further investigated, two additional pairs of comparison stars being selected for each of them, and the observations with the original pairs repeated at the same time.

Altogether there were 56 observations on 54 Piscium and 54 on Weisse 17^h, 322, distributed as follows :

54 Piscium, Mag. 6.2.

Series I.	12 obs.	with a & b	Mags. 7.5 & 7.3	(orig.)
Series II.	12 obs.	with a & b		(rep.)
Series III.	16 obs.	with c & d	Mags. 8.7 & 8.7	
Series IV.	16 obs.	with e & f	Mags. 7.5 & 5.5	

Weisse 17, 322 Mag. 8.0.

Series I.	10 obs.	with a & b	Mags. 7.0 & 8.0	(orig.)
Series II.	12 obs.	with a & b		(rep.)
Series III.	16 obs.	with c & d	Mags. 7.2 & 5.5	
Series IV.	16 obs.	with e & f	Mags. 8.6 & 7.2	

The observations treated in the customary way and the equations derived therefrom being solved, the following results were obtained:

for 54 Piscium from

Series I.	$\pi = +0''.241$	$\pm 0''.026$	Wt. 36.10
Series II.	$\pi = +0.081$	± 0.017	Wt. 42.26
Series III.	$\pi = +0.183$	± 0.035	Wt. 59.53
Series IV.	$\pi = +0.055$	± 0.023	Wt. 51.40

for Weisse 17, 322,

Series I.	$\pi = +0''.218$	$0''.030$	Wt. 33.60
Series II.	$\pi = +0.189$	0.034	Wt. 35.08
Series III.	$\pi = +0.198$	0.022	Wt. 45.87
Series IV.	$\pi = -0.047$	0.031	Wt. 38.92

The author then goes on to discuss the disparity between some of the results, which are rather amazing in view of the size of the probable errors found. He investigates the question of a possible large systematic error and concludes that any such error, if it exists, must arise from the employment of different comparison stars, and is not due to changes dependent on the time. He finds only one of the comparison stars to possess any appreciable proper motion, viz., star *c* in the first table, which amounts to $-0^s.01$ in R.A. and $0''.3$ in Decl. the proper motion of 54 Piscium, according to Porter, being $-0^s.034$ in R.A. and $-0''.38$ in Decl., and of Weisse 17^h, 322, $-0^s.040$ in R.A. and $-1''.22$ in Decl.

He finally concludes by combining the various solutions, first, by their weights, and second, by the magnitude of the probable errors, and finds the following values:

for 54 Piscium,

I. $\pi = +0''.137 \pm 0''.014$ Prob. error 1 Ob. $= \pm 0''.193$
II. $\pi = +0.117 \pm 0.011$

for Weisse 17, 322,

I. $\pi = +0''.132 \pm 0''.013$ Prob. error 1 Ob. $= \pm 0''.166$
II. $\pi = +0.140 \pm 0.014$

But the author remarks that it has been considered worth while to make still another series on Weisse 17^h, 322, with the third set of comparison stars e. f. where there is a great difference in brightness, using screens in various ways to see if difference of brightness could account for the anomalous results obtained. Meanwhile the results above given must be considered as only provisional.

'The Distance of the New Star in Perseus': Professor F. L. CHASE.

When the new star in Perseus first appeared last February it at once became the great desire of the author to determine, if possible, the parallax of this most remarkable object. So far as is known to the author, no one has as yet succeeded in determining the distance of one of these new stars. In 1892 he began a series of observations on Nova Aurigæ for the same purpose, but it will be remembered this star rapidly diminished in brilliancy, though with several fluctuations, and was not observable with the Yale heliometer for more than two or three months, which would not give a very sensible parallax factor. With Nova Persei conditions have been much more favorable, and even now the star is conspicuously brighter than the brightest comparison star employed, which was, according to Argelander, of the 7.4 magnitude.

There was but a single pair of comparison stars suitable for the purpose, viz., B.D. + 43°, 720 Mag. 7.4 and B.D. + 43°, 766 Mag. 8.0. Calling the first *a* and the second *b*, the position angles were respectively about 252° and 94°, and the distances, 2900″ and 2700″ from the Nova.

The plan was to make the observations in the usual symmetrical order *Na*, *Nb*, *Nb*, *Na*, so as to eliminate, as far as possible, the effect of refraction and other effects which may vary with the time. Since the distance, *ab*, was not beyond the range of the heliometer it was thought expedient to measure this distance also each night, and thus have besides the sums of the distances, an independent basis for correcting the changes in the scale value from night to night. Each night's work, then, consists of six observations of distance each of four pointings in reversed positions of the instrument, as follows: *Na*, *Nb*, *ab*, *ab*, *Nb*,

Na. Such observations were secured on five nights from February 26 to March 18, and seven from July 19 to August 4. These treated in the usual manner by the differences $Na - Nb$, corrected for scale value furnish seven equations of condition of the form:

$$+1.0x - 1.88y + 0.15z = \overset{(O-C)}{\underset{R}{-0.003}} \text{ or } \overset{(O-C)}{\underset{R}{-0.004}},$$

the equation derived from the observations of February 26, where $x =$ the correction to the scale value, $y =$ the parallax, and $z =$ the proper motion.

A solution of the normals derived from these equations gives:

$$y = -0\overset{R}{.}0003 \pm 0\overset{R}{.}0013 = -0''.003 \pm 0''.017 \text{ Wt. } 38.85$$

or,

$$-0.0002 \pm 0.0013 \quad -0.003 \quad 0.017 \text{ `` ``}$$

But since the distance *ab* furnishes an independent scale value, it was thought in the beginning that with this independent value we might solve the parallax from each comparison star separately, and thus see if there is any marked difference in the parallaxes of the comparison stars themselves. A closer investigation later, however, showed that this method would involve the parallaxes of the comparison stars in precisely the same manner as before, and hence would furnish nothing further than another value of the parallax relative to that of the mean parallax of the two comparison stars, differing from that already found simply by the difference in the scale value used.

The value found by this method was:

$$\pi = -0''.006 \pm 0''.022$$

as compared with

$$\pi = -0''.003 \pm 0''.017$$

given above; which agrees with the uncertainty of the computations.

The author was able to find only one of the comparison stars in any other catalogues than the A. G. Zone Catalogue for 1875, and this one shows no appreciable proper motion.

Of course the result here given must be considered as only provisional, inasmuch as nothing is known as to the proper motion of the Nova and it is barely possible that this may be such as to have just neutralized the effect of parallax. Should the star remain sufficiently bright for another six months, however, it will then be possible to determine the effect of proper motion and hence give a definitive result.

'Hyperbolic Curves of the *n*th Order': Mr. A. C. SMITH, University of Colorado.

In a plane are given n straight lines with Cartesian equations. Any point in the plane is taken as origin and through this a line is drawn intersecting the n lines in n points. In this manner n segments, measured from the origin, are obtained on the line through the origin. The algebraic sum of these segments taken on this same line will determine a point, P, which will describe a curve of the nth order as the ray through the origin rotates through 360°. It was shown how the general equation of the locus could be obtained and some linear transformations were considered.

'A Uniform Method of determining the Elements of Orbits of all Eccentricities from three Observations of Apparent Position': Dr. F. R. MOULTON, University of Chicago.

The methods of determining orbits which are in most general use were devised by Gauss one hundred years ago. They are different for orbits in which the eccentricities are less than, equal to, and greater than, unity, although there is no singularity, which is essential to the problem, for the eccentricity equal to one. The method of this paper is uniform for all orbits, it is considerably more convenient than that of Gauss, and the radius of convergence of the series employed is examined in each case.

The longitude of the node and the inclination are computed by the usual methods,

which are satisfactory, and the heliocentric distances and the arguments of the latitude at the epochs of the three observations are computed as in the method of Gauss.

Let u_1, u_2, u_3, r_1, r_2, r_3 represent the arguments of the latitude and the heliocentric distances at the epochs of the three observations. Then the parameter, p, is defined by the equation

$$k\sqrt{p}(t_3 - t_1) = \int_{u_1}^{u_3} r^2 du,$$

where r^2 is expressed as a series in u whose radius of convergence is determined as a function of u_2 and e. It is shown how the coefficients are to be found. The eccentricity, e, and the longitude of the perihelion from the node, ω, are given by

$$\left\{\begin{aligned} e\sin(u_1 - \omega) &= \left\{\frac{p - r_1}{r_1}\cos(u_3 - u_1)\right. \\ &\qquad \left. - \frac{p - r_3}{r_3}\right\}\operatorname{cosec}(u_3 - u_1), \\ e\cos(u_1 - \omega) &= \frac{p - r_1}{r_1}. \end{aligned}\right.$$

The time of perihelion passage is determined from the law of areas.

'On the Modular Functions associated with the Riemann Surface

$$s^3 = z(z-1)(z-x)(z-y)\text{'}:$$

Dr. J. I. HUTCHINSON, Cornell University.

The object of the present paper is to extend the results obtained by Picard in his memoir 'Sur des fonctions de deux variables independantes analogues aux fonctions modulaires' (Acta Math., II., p. 114). Picard considers in the first place the integrals of the first kind, and in particular the moduli of periodicity of the normal integrals. By changing the values of x, y in a continuous manner so as to return finally to their initial values, the moduli undergo a linear transformation, which can be represented by a linear transformation on two parameters, u, v, in terms of which all the moduli are rationally expressible.

These transformations forming an infinite group G can be generated by five special ones S_1 $S_2 \ldots S_5$, the explicit equations for which were given by Picard in a subsequent paper (Acta Math., V.).

The two variables x, y are then automorphic functions of u, v, and all functions belonging to the group can be rationally expressed in terms of these.

According to theorems previously obtained by Picard, there exist functions possessing a pseudo-automorphic character, exactly analogous to the fuchsian theta functions which Poincaré uses in connection with the automorphic functions of a single variable.

These functions can be constructed out of the theta constants. In order to do this it is necessary to determine the effect of the transformations of the group G on the latter, which is accomplished by means of the transformation theory of the theta functions. A table is constructed by means of which pseudo-automorphic functions can readily be constructed.

'Some Future Solar Eclipses, in particular that of June 8, 1918, total at Denver': Professor F. H. LOUD and Mr. L. R. INGERSOLL, Colorado College.

The tables used in computing the circumstances of the eclipses herein discussed are those 'On the Recurrence of Solar Eclipses' published by Professor Simon Newcomb in 1879. After some remarks upon the limits within which the errors of such a computation may be expected to fall, the results of what seems the preferable combination of Professor Newcomb's tabulated data are stated as follows:

On June 8,1918, the moon's shadow passes across the United States from northwest to southeast, covering Denver from $4^h\ 22^m\ 59^s$ P.M. to $4^h\ 24^m\ 23^s$—a period of $1^m\ 24^s$; while on the central line the duration is $1^m\ 33^s$.

The width of the shadow-path is about 59.3^m and the velocity of the shadow 2900^m an hour. The eclipse will be visible from Chamberlin Observatory, Denver, and Mt. Arapahoe, Grand Co.

Sept. 10, 1923. An eclipse of duration 3^m 24^s is total from San Diego, Cal., eastward along a line near the United States and Mexican boundary. Width of shadow-path 102 miles.

Jan. 24, 1925. An eclipse visible (as total) from northern Michigan to New Haven, Ct., reaching the latter point at 9^h 5^m A.M., and lasting 2^m 8^s.

Two maps of the Denver eclipse were shown.

'Bibliography of Quaternions and Allied Systems of Mathematics': Professor ALEXANDER MACFARLANE, Lehigh University.

The association for the promotion of quaternions and allied mathematics has in preparation a bibliography of all the literature of the subject. The field embraces all that has been written on what is called geometric algebra, or space analysis, and its three main subdivisions are quaternions, Ausdehnungslehre, and geometric algebra previous to Hamilton and Grassmann. The extent of this literature is not so small as is commonly supposed. As regards the first branch, the papers of Hamilton himself are numerous, and he has been followed by about one hundred writers. The writings of Grassmann are also numerous, and he has been followed by about the same number of writers.

It is desired to make the bibliography as complete as possible, and the writer desires mathematicians to cooperate by sending to him the necessary data about their own writings, or any rare writings in their possession.

'The Bruce Micrometer': Professor C. J. LING, Denver Manual Training High School.

The filar micrometer attached to the telescope at the Chamberlin Observatory at University Park, Colorado, is the gift of the late Miss Caroline W. Bruce. It is especially adapted to rapid work and work on faint objects. Instead of being screwed to the tail piece of the telescope, it is so attached that it slides off, thus leaving the zero of the position circle unchanged. The position circle is furnished with a system of solid stops which enable it to be turned exactly 90° when micrometric measures of both $\Delta\alpha$ and $\Delta\delta$ are being made. These stops can be rapidly thrown back, enabling the circle to be turned any desired angle, and so rapidly thrown exactly to their former position. The circle can also be clamped at any position and adjusted by the use of a tangent screw.

The eye piece can be moved rapidly in both R. A. and Decl., admitting of the use of exceptionally long and a large number of spider webs. It is possible to observe objects differing in declination by more than 30′, and this with a comparatively small motion of the micrometer. A micrometer screw of 20 threads to the inch makes rapid work possible. This is provided with three heads which are graduated so as to be read rapidly, two of which may be clamped in position.

The field is illuminated by two pairs of two candle power electric lamps whose intensities are regulated by a rheostat and mechanical shades, making it possible to rapidly adjust the illumination or to throw it off entirely. The observer can also illuminate at will either or both of the verniers of the position circle.

The results obtained from many hundreds of observations demonstrate that the micrometer is admirably adapted to combine rapidity and accuracy, making it an extremely efficient instrument, and this is all the more worthy of mention since it is accomplished without undue haste on part of the observer.

'The Metric System in the United States': Mr. Jesse Pawling, Jr., Central High School, Philadelphia.

A brief history of the action of Congress in the subject of weights and measures is given. This includes the passage by the House and failure to pass by the Senate of the bill of 1796; the petitions urging legislation in uniformity of weights and measures from various states; the bills of 1866 to legalize the metric system and to allow it for the use of the post-offices; the failure to consider the bills of 1892 for the adoption of the metric system for the exclusive use in the customs service, though urged by 150 petitions; the passage of the bill of 1896 and its reconsideration, which referred it back to the committee from which it was not reported, and the bills following this for the same purpose, the adoption of the metric system for the use of the Departments of the Government, none of which were considered.

The work of the English Decimal Association has advanced the interests of the metric system. The association has among its members, members of Parliament and business people of England. It has secured the pledges of members of Parliament to vote for the metric system. It has secured the teaching of the metric system in the schools. It circulates literature and has a lecturer who addresses audiences wherever a meeting can be secured in England. It circulates reports of consuls on the metric system in other countries. It has secured the cooperation of the labor organizations, Chamber of Commerce, and National Union of Teachers. It has no dues and any one can become a member.

A similar organization may do good work in this country for the interests of the metric system. It could secure the cooperation of Congressmen. It might aim at having the metric system taught in the schools. It could educate the people by literature and lectures like the English Decimal Association. It might secure advertisements of foreign goods in the metric system and in many other ways popularize the metric system with nominal or no dues.

'The New National Bureau of Standards': Mr. Jesse Pawling, Jr.

The new Bureau is to be located in the suburbs of Washington, where it is free from disturbance. It has an appropriation of $300,000 and a laboratory costing about $200,000 is to be erected. Great care is to be exercised in selecting the personnel, and none but those trained for the work will be employed, as it is under civil service laws. Members of the Bureau are traveling to inspect laboratories of Europe. When established the Bureau will employ a number of young men just graduated from universities, giving them opportunities to develop along the lines which they wish to follow. It will invite specialists to do work in their line.

The Bureau standardizes three grades of weights and measures:

1. Those for commercial use.
2. Those for manufacturing and technical processes and professions; and
3. Those for extreme accuracy for scientific purposes.

'A Summary of the Salient Effects due to Secular Cooling of the Earth': Professor R. S. Woodward, Columbia University.

The effects summarized in this paper are:

(*a*) The slow process of heat conduction in the earth's crust, leading to the conclusion that nothing less than a million years is a suitable time unit for recording the historical succession of events.

(*b*) The insignificant modification of the process of conduction arising from the hydrosphere, leading to the conclusion that secular cooling goes on substantially as if the earth had neither atmosphere nor ocean.

(*c*) The resultant effect on the litho-

sphere of secular contraction and the process of isostacy.

(*d*) The effects of secular contraction on the length of the sidereal day.

'The Energy of Condensation of Stellar Bodies': Professor R. S. WOODWARD.

The problem considered in this paper is that of the energy due to the gravitational condensation of gaseous matter from a state of infinite diffusion to a finite spherical mass in which Laplace's law of density holds. The problem is worked out in its generality, formulas specifying the distribution of density, pressure, and potential in the mass being given. Special attention is given to the probable case of the fixed stars of a vanishing surface density.

'The Physical Basis of Long Range Weather Forecasts': Professor CLEVELAND ABBE, U. S. Weather Bureau.

In the absence of the author and of the member who was to present it this paper was read by title. The papers by Professor See and Dr. Moulton were presented by Professor Howe. Those by Professor Dickson, Mr. Keyser, Mr. Parkhurst, Dr. Hutchinson and Professor Macfarlane were read by the secretary. All the other papers were presented by their authors. Several other papers were read before the joint session of Sections A and B. These will be included in the report of Section B.

G. A. MILLER,
Secretary of Section A.

ON THE STABILITY OF VIBRATIONS.

Observations.—The following experiment seems to me to be an interesting illustration of the equation of the damped harmonic oscillation. It also presents a striking illustration of the stability of a given type of vibration.

The necessary apparatus is very simple, consisting of an ordinary open organ pipe (say c'' of the one foot octave) and a cylindrical tin box, 4–5 cms. in diameter and 5–6 cms. long, with a central hole at one end about 1 cm. in diameter. This is adjusted so as to be of the same period as the organ pipe. A König's resonator will do equally well, but if the box has a slightly loose lid, it brings out other phenomena also deserving notice.

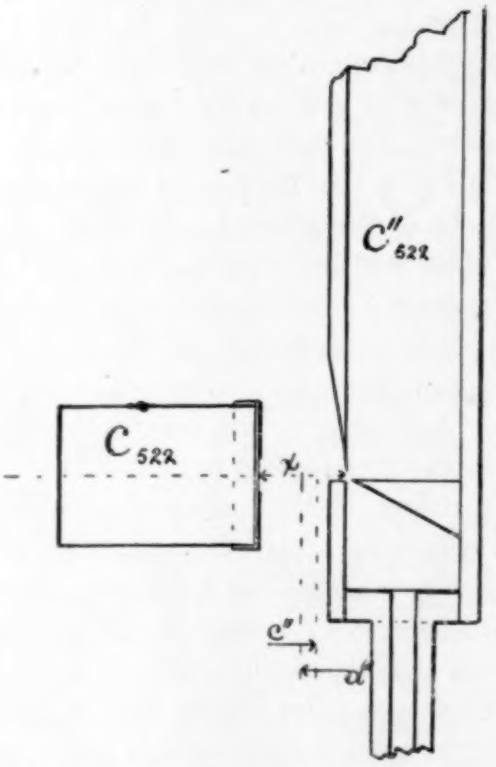
The experiment is as follows: Using a resonator giving b' to e'', depending on the intensity of the blast and with a loose (not sealed) lid, let it be placed symmetrically to the slit of the pipe at a distance, x, from it, as shown in the figure. Then as x decreases from a large distance, to say 3 cms., the resonator trembles violently (felt with the finger), but neither raises nor depresses the note. As x decreases further to 1.7 cms., no marked effect occurs, but pressure in the influx of the organ pipe will force out the octave, which it did not do before. Between $x = 1.7$ and $= 1.5$ there is destructive interference; a mere whiffing is heard from the combined instrument, but an impure octave may be forced out by pressure. Finally, when x decreases further to say 1.1 cms., a clear d'' suddenly breaks forth and is the chief feature of the experiment. For smaller distances (1.1 to .7 cms.) the d'' flattens again to c''.

The same sharpening is produced when the resonator is placed on top of the open organ pipe, mouth inward. If two resonators are used, one as in figure, the other on top, the sharpened note of the one is further sharpened by the other.

When the so-called destructive interference occurs there is no vibration in the resonator; but on pressing the finger against its bottom, the c'' may again be heard.

If the lid of the resonator be cemented on with wax, or if a round König resonator be used, there is no whiffing. The interval, x, of instability is then very small (about .2 cm.) so that the note passes very suddenly from c'' to d''. Too loose a lid merely depresses the tone at short distances.

The rise of the sharpened note will naturally depend on the pitch of the resonator. For a shorter one giving d'' to e'' with increasing blast, the above effect on the organ pipe is an e'' flat. A resonator of pitch d''



to f'' raises the organ pipe to e'' or depresses it to b', as follows: c'' at long ranges, b' at $x = 1.2$, about; b' flat at $x = 1.0$ cm., then suddenly e'' at $x = .9$ cm. Here I thought I had detected two modes of vibration of a system of two degrees of freedom; yet as the butt end of the resonator produced like depressions of tone, this is probably referable to increased friction.

A resonator of pitch a'–c'', definitely below that of the pipe, depressed the tone from c'' to c'' flat. With the butt end the depression was a whole tone. The same resonator on top of the pipe showed just perceptible sharpening. The effect seemed to be the same whether the pitch of the resonator was depressed by lengthening or by reducing the size of the mouth.

Remarks in Explanation.—As the note of the organ pipe is always depressed when the butt end of the resonator or any other obstacle is brought up to the lip, I think that a rough explanation in terms of a system of one degree of freedom will be admissible. Thus the organ pipe is vibrating throughout under more or less resistance. Its period may therefore be given by $T = 2\pi m/\sqrt{ma - b^2}$, where m is the inertia of the vibrating body, a is Hooke's constant and $2b$ the coefficient of friction. From another point of view, $T = 2\lambda m/b$, if $\lambda = Tb/2m$ is the logarithmic decrement.

If the friction is increased by presenting an obstacle at the lip, b is increased and therefore T is increased or the tone is depressed. If, however, the friction is decreased by presenting a negative obstacle—*i. e.*, the mouth of a resonator—near the lip, which initially tugs and pushes synchronously with the vibration of the lamina of air from the lip, then b is decreased and T is decreased. In other words, the tone is sharpened. It is in this way that I have presented this very striking phenomenon as an illustration of the given equation, though the full explanation cannot of course stop with a single degree of freedom.

As to the reasons for the absorption of the organ pipe note in the resonator, if its lid is somewhat loose, it is clear that this cannot be a case of ordinary interference; for in such a case there should be vibration in the resonator, whereas none is manifest to the touch at least. In other words, each successive vibration of the organ pipe is quenched in the resonator, being completely damped out. Hence the effective friction in the resonator considered alone for the given conditions is so large as to change the harmonic type of decay in the exponential type, the period becoming imaginary. Now it is interesting to note that this takes place at a particular distance, x, from the lip within narrow limits, the resonator responding strongly to c'' for larger values of x, and to d'' for smaller values. The whiffing suggests the impure octave b'', while

increased pressure at the organ pipe brings out the strong octave c'''.

Stability of vibration. Vibrational hysteresis.—Finally, the peculiar phenomenon observed in connection with the stability of vibration deserves special mention. A König resonator mounted on a graduated slide, x, is convenient for the purpose. If the mouth of this apparatus is approached slowly from a large distance, x, to within 2.2 cm. of the lip, c'' is strongly resounded. On passing these limits, d'' breaks forth almost suddenly. With this d'' sounding from the combined system, withdraw the resonator slowly again; d'' will be retained until x has increased to 2.8 cm., about. Hence, within 6 mm. of approach, the note is either c'' or d'', depending upon whether the position has been reached from large or from small values of x, within the limits given. See figure. With a carefully regulated slow influx, 9 or even 10 mm. of range were attained with a sharp clicklike breakdown at each end. The change from c'' to d'' is usually more sudden, that from d'' to c'' more gradual, perhaps, but the *hysteresis-like* character of the phenomenon is unmistakable. As I have recently been studying hysteresis* from different points of view (cf. forthcoming paper in the *Physical Review*, on temporary set), the present purely vibrational case of it is to me strikingly interesting.

CARL BARUS.

BROWN UNIVERSITY.

* *American Journal of Science*, XI., 1901, p. 97.

THE FIFTH INTERNATIONAL ZOOLOGICAL CONGRESS.

THE Fifth International Zoological Congress held its sessions in Berlin from August 12 to August 16, under the gracious protection of His Highness the Crown Prince of Germany and the presidency of Professor K. Möbius, and, so far as concerns the attendance, was the most successful of all that have so far been held. Most of the countries of Europe were well represented, delegates were present from Canada, Brazil, Mexico and the United States, the total number of those present being considerably over six hundred. The members in attendance from the United States were: Professors E. B. Wilson, of Columbia University, and Patten, of Dartmouth College; Dr. Stejneger, of the Smithsonian Institution; Dr. C. W. Stiles, of the National Museum; Mr. W. A. Murrell, of Cornell University; Mr. J. Hunter, of St. Louis, and Professor J. Playfair McMurrich, of the University of Michigan. Owing to the large number of papers to be presented, seven sections were established, namely, general zoology, experimental zoology, vertebrata (biology and systematic), vertebrates (anatomy and embryology), evertebrata (exclusive of arthropoda), arthropoda and nomenclature; and while such a separation of subjects was undoubtedly necessary and the grouping as satisfactory as might be, it made it impossible to attend the reading of many of the papers in which one might be interested.

The papers read were very varied in character, some being on special subjects, some, indeed, altogether too special for such a meeting, and others on the more general problems of zoology. If a single subject is to be selected as that which awakened the greatest interest, the new or rather the rekindled struggle between vitalism and mechanism must be the one chosen. Driesch, who has precipitated the renewal of the struggle, presented his views to a well-attended meeting of the section of experimental zoology, upholding, in a forcible and clearly stated argument, the vitalistic side of the question, while, in the discussion which followed, Ziegler, Roux and Rhumbler took the opposite side, maintaining that it is too early yet to admit the existence of vitalism or to postulate an active purpose-

fulness for the vital processes. That we cannot explain certain phenomena exhibited by living organisms on the mechanical or better the physical, hypothesis does not necessarily require the postulation of a vital force; it may rather be due to our ignorance of the physico-chemical and mechanical factors at work, and the progress of modern investigation has steadily tended towards the elucidation of more and more of the vital phenomena as chemico-physical or mechanical processes. In one of the general sessions of the Congress the same problem was the topic of a lecture by Bütschli, of Heidelberg, whose work on the structure of protoplasm necessarily inclines him towards the mechanical side. The problem, of course, cannot as yet be settled, but the opinion of the majority who took part in the discussion seemed to be in favor of the physical theory, holding that the neo-vitalists had not demonstrated the existence of a special life force or a necessity for such a force.

One of the most interesting and instructive of the lectures before the entire Congress was that given by Professor Poulton, of Oxford, on 'Mimicry and Natural Selection.' His thesis was the defense of Darwin's theory of mimicry, and in a clear and convincing manner he showed that many of the peculiarities exhibited by mimicking animals can be explained plausibly and satisfactorily on no other hypothesis. His lecture was illustrated by lantern slides, photographed in colors, showing numerous cases of mimicry in insects collected, with a special view to the study of this question, in Mashonaland, South Africa. Other lectures in the general sessions were given by Professor Grassi of Rome on 'The Malaria Problem from the Zoological Standpoint'; Professor Delage, of Paris, on 'The Theories of Fertilization'; Professor Forel, of Morges, on 'The Psychic Peculiarities of Ants'; Professor Branco, of Berlin, on 'The Fossil Remains of Man,' the last named making the rather startling suggestion that *Pithecanthropus* may have been neither man nor ape nor yet a connecting link between the two, but a cross between pliocene man and an ape!

Of the papers read before the various sections there were but few which call for special notice. One of the most important was the announcement by Professor Patten that he had been able to detect the existence of a series of three jointed appendages in specimens of *Cephalaspis* preserved in the British Museum, a fact which, taken along with the structure of the shell and the arrangement of organs which may be identified with median and lateral eyes, seems to indicate a close affinity of these supposed fishes with the merostomatous crustacea. In the section for vertebrate anatomy and embryology, Hubrecht presented the results of his studies of the development of *Tarsius*, which seem to explain the significance of the belly-stalk of the higher mammals, and Kopsch demonstrated by interesting experiments upon the blastoderm of the chick that Balfour's view that the primitive streak lay entirely posterior to the body of the embryo required considerable modification. Papers were also presented by Schauinsland on the development of the skull of *Hatteria* and of *Callorhynchus* and by Mitrophanow in the early development of the ostrich.

In the section for experimental zoology in addition to the paper by Driesch already mentioned, Herbst contributed an interesting communication on the influence of the nervous system on regenerated parts, having found that the regeneration of the eyestalk of a crab resulted in the formation of an antennule, provided the optic ganglion had been destroyed by the operation. Other interesting papers presented to this section were by Spemann, of Würzburg, on the formation of double embryos by constricting

the eggs of *Triton* in the two-celled stage, his method permitting of different degrees of constriction and of constriction in different planes, as well as a thorough study of the resulting abnormalities; and by E. B. Wilson, who gave the results of his studies on the cytological changes in the eggs of *Toxopneustes* developing parthenogenetically by the Loeb method.

In the section for systematic zoology of the vertebrates one of the most interesting exhibits was that by Sclater of the skull and a portion of the skin of the newly discovered *Okapia*, a giraffine animal closely related to the extinct *Helladotherium* and obtained in the Urganda district by Sir Harry Johnston. The papers and demonstrations in the section for invertebrata were numerous, and it is impossible to refer to more than a few of them. Most noteworthy was perhaps a magnificent collection of Hexactinellid sponges obtained from the Japanese seas and exhibited by Professor Iijima, of Tokyo, while other papers of interest were by McBride on the development of *Echinus esculentus*, Apathy on the visual cells of the Herudinea (both these with demonstrations), Hoyle on intrapallial luminous organs in the Cephalopoda and Simroth on the digestive canal of the Mollusca. The section on nomenclature devoted a considerable portion of its time to a consideration of the report of the commission proposed at the last Congress and appointed a committee to codify the rules as they now exist.

The arrangements for the meeting were admirably carried out. Through the courtesy of the president of the Reichstag the sessions of the Congress were held in the Reichstag building and everything was done to make the meeting enjoyable in every way. The death of the Empress Frederick naturally cast a gloom over the city and entailed considerable alterations in the program of excursions and festivities which had been planned by the committee, but withal they were fully successful in their efforts to make the meeting both intellectually and socially enjoyable for all those in attendance.

The next Congress will be held in Berne, Switzerland, in 1904, and Professor Studer, of Basel, was unanimously chosen as president-elect.

J. P. McM.

SCIENTIFIC BOOKS.

Annals of the Astrophysical Observatory of the Smithsonian Institution. Vol. I. By S. P. LANGLEY, Director, aided by C. G. ABBOT. Washington, Government Printing Office.

During the ten years of its existence the Smithsonian Astrophysical Observatory has been almost entirely devoted to the prosecution of a single research—a continuation of one begun some years ago by Professor Langley at Allegheny—namely, the production of a map of the absorption lines in the infra-red solar spectrum which would be in some measure comparable as regards completeness and precision with those of the visible region produced photographically with the aid of the grating. Besides this main research—and carried out largely since its completion—several subsidiary researches have been undertaken, one of which, to be mentioned later, is of particular importance.

If we represent the solar radiation by an energy curve, in the usual manner, in which ordinates are proportional to radiant energy, and abscissæ to wave-lengths, the selective absorption of the solar and terrestrial atmospheres will be indicated by depressions in the curve, whose depth and width will show the intensity of the absorption and the extent of the spectral region affected by it. In the visible region, of course, the absorption will be indicated by a great number of more or less sharp, close-packed depressions, corresponding to the great number of visible 'lines.' It has been found that, besides broad regions of general absorption previously noted by Langley and others, the infra-red spectrum is also affected by similarly sharp selective absorption, producing 'lines,' and as has been said, this main research is devoted to the mapping of

these 'lines'—that is, to the accurate determination of the details of the infra-red energy curve. It is noticeable that most of the effort has been put upon the measurement of the abscissæ of the curve (*i. e.*, wave-lengths), the ordinates being considered for the present of secondary importance; and no determination of the radiant energy in absolute measure has been attempted.

The problem can be considered as made up of two distinct parts: first, the production of a sufficiently intense, pure and well-defined solar spectrum by means which permit of the direct or indirect measurement of wave lengths; second, the detection of absorption lines in a region of this spectrum quite beyond the range of visual or even special photographic processes, and in a manner which will result in the precise location of these lines in the spectrum and in the approximate determination of their intensity and character. As a means of producing the spectrum the grating, on account of loss of energy, was necessarily discarded in favor of the prism; of glass for the shorter wave lengths, of rock salt for the longer. The observatory possesses undoubtedly the finest specimens known of the latter substance; one in particular, from the salt mines of Russia, in the form of a 60° prism with faces 13 cm. wide and 19 cm. high, having been used in the present research. The spectroscope as finally used was of the extremely convenient fixed-arm type described by Wadsworth (*Phil. Mag.*, '94) combined with a very ingenious collimating system of cylindric mirrors, due to Mr. Abbot, which enabled a slit of sufficiently small angular width to be used, while at the same time the linear width could be so great (over 0.2 mm.) that the loss of energy by diffraction at the slit was avoided. The refinement of the apparatus is shown by the fact that in the region of wave-lengths $\lambda < 2.5\mu$, a slit image of angular width $1''.5$ could be used with a bolometer of angular width $1''.2$, while for longer wave-length the values $4''.5$ or $9''$ and $3''.4$ respectively were necessary to obtain proper deflections. The Rayleigh formula for visual spectroscopic resolving power indicates that with the prism used some 1,300 lines might be detected in the region between $\lambda = .76\mu$ and $\lambda = 5.3\mu$. It is here shown that by the use of instruments of detection other than the eye the resolving power might be different and possibly greater than that given by Rayleigh's formula; and apparently this limit has been exceeded in practice. With the prism spectroscope, in order that the wave-length corresponding to a particular position in the spectrum may be known, the angle of the prism and its dispersion curve must be known; the former was determined with great care from time to time during the progress of this work, and a full discussion is given of the methods used, and of the precautions necessary when—as seems usually to be the case with rock-salt—the prism faces are curved; while the determination of the dispersion curve formed the principal subsidiary research.

As regards the method of detecting the lines, the instrument chosen was, naturally, the bolometer which for such purposes, where a linear form is essential, possesses decided advantages over any other form of radiation measurer yet devised. Instead of the usual visual observation of the motion of the spot of light reflected from the galvanometer mirror, produced by changes in the radiant energy falling on the exposed bolometer strip, a method of photographic registration was used. The spot of light fell upon a vertical photographic plate which was given vertical motion so connected mechanically with the motion of the spectrometer that each position of the plate corresponded to a definite position of the bolometer in the spectrum. The spot of light therefore occupied at any instant a position on the plate such that its one coordinate was proportional to the radiation striking the bolometer, and its other to the position of the bolometer in the spectrum; it therefore traced out the energy curve above referred to, except that the abscissæ were proportional not to the wave-length, but to the deviation produced by the particular prism used. In the form of fixed-arm spectroscope here used, the only moving part is the central table carrying the prism and a pane mirror suitably placed; if the table is given a uniform rotation, the angular motion of the spectrum past the fixed bolometer strip will be uniform also, and twice as rapid, and the particular wave-length in focus on the bolometer at any instant will have

passed through the prism at minimum deviation. The rotation of the prism corresponding to the entire range of wave-lengths here studied is less than 1° with the rock-salt prism—and hence it is necessary to be able to determine the angular position of the prism with rather unusual accuracy if the position of the bolometer in the spectrum (*i. e.*, the wave-length) is to be accurately known. The aim has been to have the maximum error in a single determination of the position of the bolometer in the spectrum not greater than $0''.6$, corresponding in the usual case to 0.1 mm. on the photographic plate. The critical part of the mechanical connection between the spectrometer and plate is a worm and wheel-segment by Warner and Swasey, which is so good that the above rigorous conditions can probably be nearly satisfied. When in use the spectrometer and plate are moved uniformly by clockwork which is, however, quite independent of the accurate mechanical connection between them, so that its errors do not enter. The photographic energy curve thus obtained by the motion of the spectrum past the bolometer strip will show besides the depressions due to the absorption lines sought, many other depressions and irregularities due to disturbances of a mechanical, electrical, magnetic or thermal nature, and a large part of the work has been an attempt to reduce to a minimum these accidental disturbances in order that the depressions in the curve due to real lines might be more clearly identified. It is impossible to consider here the causes of these irregularities—some coming from the bolometer circuit, some from the galvanometer, some from the battery, or the steps which have led to the gradual reduction of them, though these fill what is in some ways the most interesting chapter. Suffice it to say that careful comparison of a number of the best curves, or bolographs as they are called, has resulted in the more or less certain identification of over 700 lines in the region from $\lambda = 0.76\mu$ to $\lambda = 5.3\mu$ whose wave-lengths are determined with a mean probable error of two or three Ångstrom units, the results being given in tables, containing also indications as to the character and grouping of the lines. A graphic representation is also given in the form of line spectrum maps, both normal and prismatic, either drawn by hand from the tabulated results, or transformed in a semi-automatic way from some of the curves themselves. This process seems of doubtful value, however, as the line-spectrum conveys in reality less information than the curves themselves, while it is apt to produce a false impression of authenticity. Curves and tables are also given illustrating the changes which occur, seasonal and otherwise, in the intensity of many infra red absorption lines; changes whose existence is here definitely fixed, but which will have to be further investigated before their cause can be assigned.

The most important subsidiary research has been the determination of the dispersion curves of rock-salt and fluorite; the former by direct comparison (so to speak) with a grating, the latter by comparison of fluorite bolographs with rock-salt bolographs of the solar spectrum, and measurements of the deviation of the same lines in both. Langley's early method was substantially repeated here in the work with rock-salt, and is briefly as follows:

Radiation from whatever source is used falls first upon the slit of a Rowland concave grating spectroscope, the eyepiece of which is replaced by a second slit; the radiation passing this second slit, from the grating, goes through the optical train of the prism spectroscope and is brought to focus at the proper place in the dispersion spectrum of the particular prism used. If the grating is set so as to let through the second slit light of a known (visible) wavelength in (say) the 3d order spectrum, waves of $\frac{3}{2}$ and 3 times this length will also pass through, belonging to the 2d and 1st order spectra. Hence in the dispersion spectrum of the prism there will be three distributions of energy, more or less sharp according to the widths of the two slits; and if a bolograph of this spectrum is taken in the usual way, three maxima will appear, separated by regions indicating no radiation. If on the same plate a record of the 'A' line is made, the relative deviation of the maxima (due to known wave-lengths) with respect to the 'A' line, can be determined by measurement of the plates. Such records, combined with the determination of the absolute deviation of the 'A' line, and of the angle

of the prism, gave the data for plotting the dispersion curve of rock-salt. The results, exceeding in accuracy any heretofore obtained, and which will be of the greatest value to other investigators using rock-salt dispersion for infrared work—are given in several convenient forms, most conveniently, perhaps, in the shape of a very large scale curve, extending between the limits $\lambda = 0.5\ \mu$ and $\lambda = 6.5\ \mu$, from which indices of refraction can be read off to 0.000002, and for which the probable error lies usually between 0.000009 and .000018. The dispersion curve of fluorite is given on the same scale between the limits $\lambda = .75\ \mu$ and $\lambda = 3.5\ \mu$. From the data for rock-salt have been calculated the five constants of the Ketteler dispersion formula, which differ quite noticeably from those calculated by Rubens and Trowbridge for a longer wave-length interval; but the differences between the observed and computed values of index of refraction are hardly greater than the probable errors of deviation, except for the longest wave-lengths. Accurate comparisons have also been made of the dispersion of three rock salt prisms which confirm the view that rock-salt as found in nature is in one respect of great optical uniformity, so that accurate determinations of indices of refraction for one prism can be safely applied to another for the purpose of determining wave-lengths; an extremely fortunate circumstance.

It is impossible to do more than mention some of the lesser pieces of work here recorded —such as the determination of the energy curves of various incandescent mantles; tests of the accuracy or constancy of the bolometer, which unfortunately do not touch the most difficult point, *i. e.*, constancy as regards sensibility for long time intervals; and a study of the minute structure of the infra red absorption band 'ω_1.' A considerable space is, appropriately, devoted to the discussion of errors, and to methods for overcoming difficulties inherent in bolometric work; of which the most troublesome are undoubtedly 'drift,' or the continuous change in the zero position of the galvanometer spot of light, and the more or less rapid periodic changes of zero, or 'wiggle.' The various precautions taken, which have finally almost eliminated the drift and greatly reduced the 'wiggle,' are dealt with in full; few of them altogether new perhaps, but certainly applied here with greater completeness and care than has been done elsewhere. The detailed consideration of manipulation and construction will be of great value to others engaged in similar work. In particular should be mentioned the study of the behavior of rock-salt prisms under conditions of rising temperature; the question of the construction of linear bolometers, in which such skill has been attained, and of the design of balancing bridges; and the full discussion of the adjustments of the fixed-arm spectroscope. In the chapter on the galvanometer will be found a useful table of the computed axial magnetic force produced by galvanometer coils of various resistances, wound either with a single size of wire or with different combinations of three sizes, which not only shows clearly the advantage of sectional winding, but will be a valuable aid in the design of galvanometers. The use of the Ayrton-Mather scale for expressing galvanometer sensibilities, now so generally adopted, would have rendered easier the comparison of the observatory instrument with others.

The valuable and interesting material, which it has been here attempted briefly to summarize, is the result of about nine years of work, involving the labors, successively, of Dr. Hallock, Mr. Wadsworth, Mr. Child and, for a longer time, of Mr. Abbot and Mr. Fowle, all under the direction of Professor Langley. From time to time statements of the progress of the work have been made by Professor Langley, and some special points considered in papers of Mr. Wadsworth, Mr. Abbot and Mr. Fowle, but the results now made public are so interesting and so important to all engaged in similar work that it is to be hoped that in the future conditions affecting publication by the government may allow more frequent and less delayed reports from this observatory, which is unique in its possibilities for the highest class of work with radiant energy.

C. E. MENDENHALL.

Dynamo Electric Machinery. Its construction, design, and operation. Direct current machines. By SAMUEL SHELDON, A.M., Ph.D.

Assisted by HOBART MASON, B.S. 12 mo. Pp. 281. Price, $2.50, net.

The appearance of a promising new text-book on a subject relating to electrical engineering in any of its phases is a matter of much interest in the engineering schools; but Dr. Sheldon's book on 'Dynamo Electric Machinery' may justly receive special attention on account of the author's experience as a teacher and writer, his reputation for vigor, and the evident care with which he has constructed the book. Covering a field in which there are many books, the new comer finds an ample demand which is unfulfilled; for none of the older books are completely satisfactory as text-books and few are more successful as reference books. The demand for a really successful college text-book on applied electromagnetism and the construction of dynamos is therefore large and crying, and the new comer was assured of a certain effusiveness of welcome from technical college circles.

It then becomes a matter of interest to scrutinize the book and learn whether it fulfills those important requirements that are yet unfulfilled by existing literature; and it is a satisfaction to say that in many respects it bears the scrutiny well. In order of treatment and clearness of exposition the book is admirable, as it also is in typography and in much of the illustrative matter. The book has characteristics which are excellent in one designed for classes of trained mechanics, and perhaps the shorter and in some respects more superficial 'information courses' of instruction, which are given in our engineering schools to classes of men who are not following the professional course in electrical engineering and for whom the allotment of time to the subject of dynamos is insufficient for the most approved scientific instruction.

Dr. Sheldon's book was thus used during the past year in the University of Wisconsin as the text-book for a short course of study in dynamos required of mechanical engineering students. In this place the book proved successful, though several predecessors that presumably occupy a similar field had failed to give satisfaction. It is also expected that Dr. Sheldon's book will give good results in the better classes of the Summer School for Apprentices and Artisans which has just completed its first session at the University of Wisconsin.

For the longer course in applied electromagnetism and the construction of dynamos that should be presented to the men pursuing a college course in electrical engineering, this book does not appear to be so well adapted. Such a course should deal in principles, principles, principles; and it should be remembered that good results involve much labor on the part of the student, however much interested he may be. In the small compass of Dr. Sheldon's book, so much space is occupied by descriptions and illustrations of the commercial apparatus of the day that the principles of electromagnetism and the modes of their application cannot be adequately treated.

We have no text-book on this subject which satisfactorily meets the requirements of a thorough treatise for the 'electrical engineering students' of our colleges, and we may justly say that it is better to use as a syllabus for these classes some book which deals sensibly and with reasonable adequacy in the theory of electromagnetism, than to use a book like Dr. Sheldon's which is of the so-called 'more practical' character. This choice of the preferable plan casts much labor on the teacher; but where the best teaching is the object, labor cannot be shirked.

To meet the requirements of the college classes to which I refer, a book is required of much greater scope than Sheldon's and much greater volume. One may doubt whether Sheldon's book was seriously planned for such classes, as the author's intention is stated in his preface to be to write a book 'to be used primarily in connection with instruction on courses of electrical engineering in institutions for technical education'; and also to meet the wants of '*the general reader, who is seriously looking for information concerning dynamo electric machinery* of the types discussed, * * *.' The object which I have set forth in italics has been well attained. It is obviously impossible to attain this object, and also to meet the requirements of extended scientific instruction, in the subject of this book, all within the covers of a duodecimo volume of 281 pages.

One object well attained is success, and it is to be hoped that the book will reach sufficient sales through the reasonable accomplishment of this object, so that the author may be encouraged to write another and more extended volume which may meet the needs of the electrical engineering students.

The author is to be congratulated upon the remarkable freedom of his first edition from typographical errors. In other respects he is perhaps not always so fortunate, as in some of his definitions, which are not always adapted to give a proper physical conception to the student. Also, in certain parts of the book, the descriptive matter is inexact or inadequate —especially is this true in the chapter on armature windings, where no attempt is made to present the rational laws of windings, and the short descriptions are inadequate and the diagrams too small to be thoroughly serviceable. Such faults, however, may be readily corrected in another edition, the compliment of an early demand for which we cordially wish for the author.

All in all, we heartily welcome the book to a useful sphere and compliment the author on his success. But we must regret that he did not make a book which might occupy the more important place of a scientific college textbook on applied electromagnetism and the construction of dynamos.

Dugald C. Jackson.

DISCUSSION AND CORRESPONDENCE.

A NEW FIELD FOR KITES IN METEOROLOGY.

To the Editor of Science: Although kites carrying recording instruments to a height exceeding three miles have rendered great services to meteorology at Blue Hill and elsewhere, they have been subject to the limitation of requiring a wind that blows at least twelve miles an hour. In certain types of weather—notably anti-cyclones—the winds are light and consequently observations with kites can rarely be obtained at these times. It also happens frequently that, while the wind at the ground is sufficient to raise the kites, it fails completely above the cumulus clouds so that the kites are unable to penetrate this calm zone.

By installing the kites and apparatus on a steamship, not only can kites be flown in calm weather, but observations may be made above the oceans where little is known about the conditions of the upper air. It is evident that a vessel steaming twelve knots an hour through a calm atmosphere will raise the kites to the height they would attain in a favorable natural wind, while the force of strong winds can be moderated by steaming with the wind. In this way, kites can be flown on board a steamer, under almost all conditions and probably more easily than on land, since the steadier winds at sea facilitate launching them. Wherever these observations in the upper air may be made, there is always a station at sea-level and not far distant horizontally with which to compare them.

To test the practicability of this method of flying kites, experiments were undertaken on August 22, 1901, with the aid of my assistants, Messrs. Fergusson and Sweetland, upon a towboat chartered for this purpose to cruise in Massachusetts Bay. Anti-cyclonic weather conditions prevailed, and a southeast wind blew from 6 to 10 miles an hour, but at no time with sufficient velocity to elevate the kites, either from sea-level or from the summit of Blue Hill. With the boat moving 10 miles an hour toward the wind, and within an angle of forty-five degrees on either side of its mean direction, the resultant wind easily lifted the kites and meteorograph with 3,600 feet of wire to the height of half a mile.

While it is desirable to have a vessel that can be started, stopped and turned at the will of the meteorologist, as was the case in the experiments described, it is nevertheless probable that soundings of the atmosphere can often be made from a steamship pursuing its regular course, and such are about to be attempted by me on a steamer eastward bound across the North Atlantic. Although observations above all the oceans are valuable, the exploration of the equatorial region is the most important, since, with the exception of a few observations on the Andes and on mountains in central Africa, we know nothing of the conditions existing a mile or two above the equator. The need of such data to complete our theories of the thermo-

dynamics and circulation of the atmosphere was urged by the Russian meteorologist, Woeirof, at the Meteorological Congress in Paris last year. North and south of the equator, within the trade-wind belts, kites might be employed to determine the height to which the trades extend, and also the direction and strength of the upper winds, concerning which the high clouds, rarely seen in those latitudes, furnish our only information. In order to deduce the velocity of the upper current from the resultant velocity recorded at the kite, it is necessary to ascertain the direction of this latter force, which could be done from the orientation of the kite.

A. LAWRENCE ROTCH.

BLUE HILL METEOROLOGICAL OBSERVATORY, August 24, 1901.

GRADUATE COURSES IN SCIENCE.

AT the request of the editor, I have drawn up a list of the graduate courses in pure science offered by several of our leading universities during the academic year 1901–1902. Chicago, Columbia, Cornell, Harvard, Johns Hopkins, Pennsylvania and Yale have been chosen because during the past four years each of these universities has almost invariably conferred from 20 to 40 doctorates of philosophy, whereas no other university in our country has on the average conferred more than eight.

This information has been collected from the most recently issued announcements of graduate courses to be given by the respective universities during the ensuing academic year, and has been made as complete as the material at command will permit. In some instances the announcements of courses fail to distinguish clearly between primarily undergraduate courses and purely graduate courses, and the compiler has in such cases endeavored to discriminate as carefully as possible. Wherever the information has been obtainable, there is added in parenthesis to the announcement of each course the number of hours a week for which that course is scheduled. Unless otherwise stated, the common denominator employed is the unit hour per week during the entire academic year. Laboratory hours are distinguished by italics. The graduate courses given at the University of Chicago during the summer quarter of 1901 have been omitted, as also the graduate courses given at the recent summer sessions of several of the universities.

ANATOMY.

(Consult also Zoology.)

Chicago.

Professor Barker: Seminar; Advanced work and original research.

Columbia.

Professor Huntington: Laboratory courses in animal morphology.

Harvard.

Professors Dwight and Dexter: Research course in anatomy.

Johns Hopkins.

Professors Mall, Harrison and Bardeen: Advanced work and original investigation (daily).

Professors Mall, Harrison, Drs. Sudler, Lewis: Systematic instruction in gross human anatomy (afternoons).

Professor Bardeen, Drs. Knower, MacCallum: Systematic instruction in histology, microscopic anatomy, neurology, and embryology (mornings).

Pennsylvania.

Professor Jayne: Research in human anatomy.

Yale (see Zoology).

ANTHROPOLOGY.

Chicago.

Professor Starr: Physical anthropology, lab. (*4*); Laboratory work in anthropology (*4*); Japan (4, 6 wks.); Pueblo Indians of New Mexico (4, 1 qr.).

Columbia.

Professor Boas: Ethnography of America (2); Statistical study of variation (2); Physical anthropology (2); American languages (2).

Professor Farrand: General introductory course (2); Ethnology, primitive culture (2).

Professors Boas and Farrand: Research work in physical anthropology, ethnology and North American languages (daily).

Harvard.

Professor Putnam: American archeology and ethnology (research).

Drs. Woods, Dixon: General anthropology (3).

Dr. Dixon: Primitive religions ($1\frac{1}{2}$); Special ethnology ($1\frac{1}{2}$).

Yale.

Professor Sneath: Philosophical anthropology (2).

Professor Sumner: (See Sociology and statistics.)

ASTRONOMY.

Chicago.

Professor Hale: Solar physics (8); Stellar spectroscopy (8); *ditto* (4).

Professor Frost: Astronomical spectroscopy (4); Stellar spectroscopy (4); Celestial photometry (4, 1 qr.).

Professor Laves: Theory of absolute perturbations (4, 1 qr.); Theory of attractions and figures of the heavenly bodies (4, 1 qr.).

Professor Moulton: Theory of orbits and special perturbations (4, 1 qr.); Lunar theory (4, 1 qr.).

Professors Hale, Barnard, Frost: Astronomical and astrophysical research.

Columbia.

Professor Rees: General astronomy (2); Spherical and practical astronomy (2 + *2*); Geodesy, theory (1); Advanced spherical and practical astronomy (2 + *4*).

Professor Jacoby: Geodesy, applications (1); Summer school in practical geodesy (6 wks.); Theoretical astronomy (1); Theory and method of reduction of photographic star plates (1).

Professors Rees and Jacoby: Geodesy (1); The method of least squares, with applications to astronomy and to geodesy (1).

Dr. Mitchell: Astronomical spectroscopy (1).

Cornell.

———: Descriptive and theoretical astronomy (2).

Harvard.

Professor Pickering: Practical observatory work.

Professor Wilson: Practical astronomy (3).

Johns Hopkins.

Dr. Huff: Elements of astronomy (1).

Pennsylvania.

Professor Doolittle: Method of least squares (1); Reduction of stellar coordinates (1); History of astronomy (1); Observatory practice (6); Practical astronomy (3).

Mr. Eric Doolittle: Theoretical astronomy (2 and 3); Secular perturbations (3).

Yale.

Professor Beebe: Practical astronomy (2).

BACTERIOLOGY AND PATHOLOGY.

Chicago.

Professor Jordan: Research in bacteriology.

Drs. Hektoen, Wells: Research in pathology (*4* or *8*).

Columbia.

Professor Prudden and Drs. Hiss, Leaming: Advanced bacteriology with research (*afts.*, *3 mos.*).

Dr. Hiss: Advanced bacteriology (*afts.*, *3 mos.*).

Harvard.

Professor Ernst: Research courses.

Johns Hopkins.

Professor Welch and assistants: Bacteriology (laboratory), (*3 hlf. days a wk.*, 3 *mos.*); Infection and immunity (1 or 2, 3 mos.); General pathology, pathological anatomy and pathological histology (*3 afts a wk.*, *5 mos.*); Advanced work and special research.

Dr. MacCallum: Demonstrations in gross morbid anatomy (1); Conduct of autopsies.

BOTANY.

Chicago.

Professors Coulter, Barnes, Drs. Davis, Chamberlain: Research in Morphology (*4* or *8*).

Professor Coulter, Dr. Chamberlain: Special morphology of the pteridophytes (8, 1 qr.).

Professor Barnes: Special morphology of bryophytes (8, 1 qr.).

Professor Barnes, Mr. Livingston: Plant physics (4, 1 qr.); Plant chemics (4, 1 qr.); Growth and movement (4, 1 qr.).

Dr. Davis: Organic evolution (4, 1 qr.); General morphology of the bryophytes and pteridophytes (4, 1 qr.); General morphology of the spermatophytes (4, 1 qr.); Special morphology of the algæ (4, 1 qr.).

Dr. Chamberlain: Elementary histology (4, 1 qr.); Field botany (4, 1 qr.); Cytology (4, 1 qr.).

Dr. Cowles: Ecological anatomy (4, 1 qr.); Geographic botany (4, 1 qr.); Physiographic ecology (4, 1 qr.); Seminar in ecology (4 or 8); Research in ecology (4 or 8).

Columbia.

Professor Underwood: Morphology of fungi (*10*); Morphology of bryophyta (*10*); Morphology of pteridophyta (*10*); Taxonomy of fungi (*10*); Taxonomy of bryophyta (*10*); Taxonomy of pteridophyta (*10*).

Professors Underwood, Britton: Regional botany (*10*).

Professor Lloyd: Experimental morphology (*10*); Embryology of spermatophyta (*10*); Ecology (*10*).

Professor Britton: Taxonomy of spermatophyta (*10*).

Dr. Curtis: Plant physiology (2); General physiology (*10*); Physiological anatomy (*10*).

Dr. Howe: Morphology of algæ (*10*); Taxonomy of algæ (*10*).

Dr. MacDougal: Physiology of the cell (*10*); Ecological physiology (*10*).

Dr. Richards: Physiology of nutrition (*10*).

Dr. Rydberg: Morphology of spermatophyta (*10*).

Mr. Nash: Taxonomy of gramineæ (*10*).

Cornell.

Professor Atkinson and assistants: Comparative morphology and embryology (3); Mycology (3); Taxonomy of the bryophytes and pteridophytes (3); Methods of research in morphology and embryology (4); Plant physiology (4); Seminary in embryology, mycology, physiology etc. (1).

Professor Rowlee and Dr. Wiegand: Taxonomy and phylogeny of angiosperms (3); Comparative histology of plants (3); Dendrology (3); Research in taxonomy and phylogeny of the angiosperms (4); Research in comparative histology and cytology (4).

Harvard.

Professor Goodale: Morphology, histology and physiology of flowering plants (2); Principles of botanical classification, ecology and plant distribution (3); Structure and development of phanerogams (research).

Professor Thaxter: Cryptogamic botany (1½); Structure and development of cryptogams (research).

Johns Hopkins.

Dr. Johnson: Comparative morphology of the vegetable kingdom (2 + *2*); Physiology and histology

of plants (2); Botanical journal club (1); Botanical seminary (1).

Pennsylvania.

Professor MacFarlane: Comparative histology of plants (1 + *2*); Plant irritability and nutrition (1 + *5*); Comparative morphology of the gymnosperma (2 + *4*).

Dr. Harshberger: Comparative taxonomy of plants (1 + *2*); Comparative morphology of the myxomycetes and fungi (1 + *4*).

Yale.

Professor Evans: Botany of the flowering plants (1½); General morphology of plants (4); Advanced morphology and taxonomy of plants.

Dr. Coe: Cytology and general embryology (2).

CHEMISTRY.

Chicago.

Professor Nef: Organic chemistry (4); Organic preparations (*10* or *20*); Research in organic chemistry (*30* to *40*); Special chapters of organic chemistry (4 hrs., 6 wks.); Journal meetings.

Professor Smith: Advanced general chemistry (4 hrs., 1 qr.); Research in general chemistry (*30* to *40*).

Professor Lengfeld: Inorganic preparations (*10* or *20*); Research in inorganic chemistry (*30* to *40*); Advanced inorganic chemistry (2 hrs., 1 qr.); Physico-chemical methods (5 hrs., 6 wks.).

Professor Stieglitz: Advanced qualitative analysis (*10* or *20*); Advanced quantitative analysis (*10* or *20*); Special methods in quantitative analysis; Research in organic chemistry (*30* to *40*); The aromatic series (*2*).

Dr. Jones: Elementary spectrum analysis (qualitative) (2 hrs. 1 qr.).

Columbia.

Professor Pellew: Industrial chemistry, special applications, laboratory (*3½*); Industrial chemistry, preparation of chemicals (1); Industrial chemistry, advanced course.

Professor Bogert: Advanced organic chemistry, laboratory (*12*); *ditto*, research.

Professor Bogert and Dr. Caspari: Chemistry of methane and its derivatives (3); Chemistry of the carbocyclic and heterocyclic compounds (3); Organic chemistry, general laboratory course.

Professor Miller: Quantitative analysis, special methods (*16*); Advanced inorganic analysis (2 + lab.); Assaying, ores and metallurgical products (*2*); Special methods of assaying ores, alloys and furnace products (*4*).

Professor Morgan: Physical chemistry (3 + lab.); Physical chemistry, advanced (2 + *12*).

Dr. Wells: The spectroscope as applied to qualitative and quantitative analysis (*20*).

Dr. Jouët: Quantitative analysis.

Dr. Sherman: Proximate organic and sanitary analysis, quantitative (4 + *12* or *18*); Advanced proximate organic analysis (2 + lab.).

Cornell.

Professor Caldwell: Agricultural qualitative and quantitative analysis, advanced course; Beverages and foods (1).

Professor Dennis: General inorganic and ultimate organic analysis, advanced; Spectroscopic chemical analysis and colorimetry (1½); Qualitative and quantitative gas analysis (½); Technical gas analysis; Inorganic chemistry, advanced (3); *ditto* (laboratory); Inorganic chemistry, seminar (1).

Professor Trevor: Mathematical chemistry (3); Advanced mathematical chemistry (1).

Professor Bancroft: Physicochemical methods (3); Advanced physical chemistry (3); Advanced laboratory work, physical chemistry.

Professor Orndorff: Organic chemistry (3 + *3*); Special chapters in organic chemistry (2); Advanced organic chemistry, laboratory; The coal tar dye-stuffs (½); Stereochemistry (½); Seminar in organic chemistry (1).

Dr. Chamot: Food and water analysis (*3*); Microchemical analysis (3); Potable water (1); Toxicology (1); Toxicological chemistry (½).

Dr. Carveth: Introductory physical chemistry (2).

Mr. Cushman: Technical and engineering analysis; Assaying (3).

Harvard.

Professor Hill: Carbon compounds (3); Organic chemistry (research).

Professor Jackson: Organic chemistry (research).

Professor Richards: Historical development of chemical theory (1); Advanced quantitative analysis (1½); Gas analysis (1½); Physical chemistry, (3); Inorganic chemistry, including determination of atomic weights (research); Physical chemistry (research).

Professor Sanger: Applied chemistry (research).

————————: Electrochemisty (1½.)

Johns Hopkins.

Professor Remsen: Compounds of carbon (3); Historical topics in chemistry (12 lectures).

Professor Morse: Advanced inorganic chemistry (2).

Professor Jones: Physical chemistry (3); Elements of physical chemistry (1).

Pennsylvania.

Professor Smith: Advanced inorganic chemistry (2); History of chemistry (½); Electrochemistry (1); Mineral analysis (½); Analytical chemistry (½); Seminary (1).

Dr. Lorenz: Organic chemistry (2); Gas analysis (lab.); Physical chemistry (lab.).

Dr. Shinn: Industrial chemistry (1).

Yale.

Professor Mixter: Chemical physics.

Professor Wells: Qualitative analysis (1 + lab.); Quantitative analysis; Inorganic preparations; Advanced quantitative analysis; Metallurgy and assaying; Technical gas analysis; Investigations in inorganic chemistry.

Professor Gooch: Quantitative analysis (6); Chemical theory (1); Special methods; Research in inorganic chemistry.

Professor Wheeler: Advanced organic chemistry; Organic preparations.

Professor Browning: The rare elements (1); Inorganic preparations (2).

Dr. Locke: Systematization of inorganic compounds; Advanced inorganic chemistry; Application of the ionic theory to analytical chemistry; Constitution of chemical compounds.

Dr. Foote: Physical and electro chemistry (1); Physico chemical measurements (lab.); Electrochemistry (lab.).

Dr. Phelps: The carbon compounds (2); Organic synthesis (lab.).

Mr. Comstock: Elementary organic chemistry; Organic chemistry (1).

GEOLOGY (INCLUDING GEOGRAPHY).

Chicago.

Professor Chamberlin: Principles and theories of geology (6).

Professors Chamberlin and Salisbury: Special geology, selected themes.

Professor Iddings: Petrology (4 or 8); Special petrology (4 or 8).

Professor Weller: Special paleontologic geology (4 or 8).

Columbia.

Professor Kemp: Economic geology ($1\frac{1}{2}$); Petrology ($2+4$); Geological examinations and surveys (1).

Professor Dodge: Elementary physical geography, and geography of the United States (3).

Dr. Hollick: Paleobotany ($1+4$).

Dr. Jubin: Geology of building-stones (1); Metamorphism (1).

Dr. Grabau: Invertebrate paleontology ($2+4$).

Cornell.

Professor Tarr and assistants: Dynamic, structural and physiographic geology ($2+2\frac{1}{2}$); Physical geography ($3+$); Elementary meteorology (1); Glacial geology (3); Geological investigation; Seminar (2).

Professor Harris: Geological research in America (2); Conchology (2); Paleontological illustration ($\frac{1}{2}$); Field and laboratory work.

Dr. Ries: General economic geology (3); Clay investigation; Advanced economic geology.

Harvard.

Professors Shaler, Davis, Wolff, Smyth, Woodworth, Dr. Jaggar: Geological investigation in the field and laboratory.

Professors Shaler and Jackson: General paleontology (3); Historical geology (1); Advanced paleontology.

Professor Davis: Physiography of Europe ($1\frac{1}{2}$); Physiography, advanced (2).

Professor Smyth: Mining geology (3); Economic geology ($1\frac{1}{2}$); Mining geology, advanced (2).

Professor Jackson: General paleontology ($1+4$).

Professor Woodworth: General critical geology (3); Glacial geology ($1\frac{1}{2}$).

Professor Ward: General climatology ($1\frac{1}{2}$); Climatology of the United States ($1\frac{1}{2}$).

Dr. Jaggar: Advanced geological field work (2); Structural and dynamical geology of the United States (1).

Johns Hopkins.

Professor Clark and assistants: General geology (4); Paleontology (2); Historical geology (2).

Professor Reid: Experimental geology (1); Geological physics (1); Exploratory surveying (1).

Professor Abbe: Meteorology.

Dr. Shattuck: Physiographic geology (1).

Dr. Fassig: Climatology (1).

Mr. Willis: Stratigraphic and structural geology (1).

Dr. Bauer: Terrestrial magnetism.

Pennsylvania.

Professor Brown: Historical geology ($1+4$); Petrography ($1+4$); Chemical geology ($1+4$).

Dr. Ehrenfeld: Physical geology and physiography ($1+3$).

Professor Brown and Dr. Ehrenfeld: Paleontology of the invertebrates (5).

Yale.

Professor Williams: Historical geology (4); Evolution theories (2); Geological surveys; Practical geology.

Professor Beecher: General invertebrate paleontology (1); Invertebrate paleontology, faunal; Invertebrate paleontology, special; Research in invertebrate paleontology; Organic evolution; Taxology; Historical geology.

Professor Pirsson: Petrology; Elementary petrology ($\frac{1}{2}$); Elementary structural and dynamical geology ($1\frac{1}{2}$).

Dr. Gregory: Physiography.

MATHEMATICS.

Chicago.

Professors Moore, Bolza, Maschke: Mathematical reading and research.

Professor Moore: Theory of functions of real variables (4, 1 qr.); General arithmetic (4, 2 qr.); Seminar, Theory of functions of real variables (4, 2 qr.).

Professor Bolza: Abelian functions (4, 1 qr.); Seminar, Theory of abelian functions (4, 1 qr.).

Professor Maschke: Twisted curves and surfaces (4, 1 qr.); Theory of invariants (4, 1 qr.); Theory of functions (4, 2 qrs.); Seminar, differential geometry (4, 1 qr.).

Professor Dickson: Theory of numbers (4, 1 qr.).

Columbia.

Professor Fiske: Advanced calculus (3); Functions defined by linear differential equations (3).

Professor Cole: Theory of groups (3).

Professor Maclay: Theory of functions of a complex variable (3).

Mr. Keyser: Modern theories of geometry (3).

Cornell.

Professor Wait: Advanced analytic geometry (1); Advanced calculus, differential (3).

Professor Jones: Higher algebra and trigonometry (3); Theory of probabilities and least squares (2).

Professor Tanner: German mathematical reading (2); Algebraic invariants (2).

Professor McMahon: Quaternions and vector analysis (2).

Dr. Snyder: Projective geometry (3); General theory of algebraic curves and surfaces (3); Theory of functions (3).

Dr. Hutchinson: Advanced integral calculus (2); Theory of function (3).

Mr. Fite: Theory of groups (3); Theory of numbers (3).

——: Differential equations, advanced (3).

Harvard.

Professor J. M. Peirce: Calculus of quaternions (3); Theory of triangular coordinates and algebraic

plane curves (3); Application of quaternions to the theory of curves and surfaces (1½); Selected topics in quaternions (1½).

Professor Byerly: Advanced differential and integral calculus (3); Trigonometric series, spherical harmonics, potential function (3); Research, Picard's Traité d'Analyse, Vol. I.

Professor B. O. Peirce: Trigonometric series, spherical harmonics, potential function (3).

Professor Osgood: Infinite series and products (1½); Theory of functions (3); Research, calculus of variations.

Professor Bôcher: Higher algebra, polynomials and invariants (1½); Partial differential equations (1½); Linear differential equations of the second order (3).

Dr. Bouton: Theory of numbers (1½); Elementary theory of differential equations (1½).

Mr. Coolidge: Theory of equations, invariants (1½); Non-Euclidean geometry (3); Research, projective geometry.

Mr. Whittemore: Modern methods in geometry, determinants (3).

Johns Hopkins.

Professor Morley: Advanced geometry (3); The differential equations of physics (1); Mathematical seminar (1).

Dr. Cohen: Advanced differential equations (2); Theory of algebraic numbers (2); Elementary theory of functions (2).

Dr. Franklin: Probability.

Pennsylvania.

Professor Crawley: Plane analytic geometry (2); Higher plane curves (3).

Professor Fisher: Differential equations (2); Invariants and covariants (3); Theory of functions of a real variable (1½); Theory of functions of a complex variable (1½).

Professor Schwatt: Infinite series and products (3); Definite integrals and the functions of Bessel, Laplace and Lamé (3).

Dr. Hallett: Theory of substitutions (2); Theory of groups (2).

Department officers: Mathematical seminar.

Yale.

Professor Clark: Determinants (1); Differential equations (1).

Professor Gibbs: Vector analysis (1½); Advanced vector analysis (1½).

Professor Pierpont: Higher algebra (1½); Differential equations and function theory (3); Theory of functions (3).

Professor Smith: Advanced differential geometry (2); Foundations of geometry (1).

Dr. Porter: Advanced calculus (3); selected topics in differential equations (1½).

Dr. Granville: Differential geometry (1½).

Mr. Wilson: Projective geometry (1½).

MECHANICS.

(Consult also Physics.)

Chicago.

Professor Maschke: Theory of the potential (4, 2 qr.).

Dr. Gale: Dynamics (4, 1 qr.).

Columbia.

Professor Woodward: Analytical mechanics (3); Advanced theoretical mechanics (2); Theory of the potential function (2); Geodynamics (2); Mathematical theory of elasticity (2); Theory of the conduction of heat in solids (2).

Professor Pupin: Thermodynamics (1½); Theory of dynamo and motor (1½); Theory of direct-current dynamo (1½); Theory of alternators and transformers (1½); Theory of variable currents (1½); Maxwell's theory of electricity and magnetism (2); Theory of Bessel's functions and spherical harmonics (1); Electro-magnetic theory of light (1½); Advanced thermodynamics (2); Theory of oscillations (2).

Mr. Pfister: Theoretical mechanics (2).

Cornell.

Professor Trevor: Mathematical theory of thermodynamics (2).

Professor McMahon: Theoretical mechanics (2); Potential function, Fourier's series and spherical harmonics (2); Mathematical theory of sound (2).

Professor Merritt: Electricity and magnetism; Theoretical physics, mechanics and thermodynamics (4).

——————: Mathematical theory of fluid motion; Mathematical theory of electricity and magnetism.

Harvard.

Professor Hall: Elements of thermodynamics (1½); Modern developments and applications of thermodynamics (1½).

Professors Byerly and B. O. Peirce: The potential function (3).

Professor Byerly: Dynamics of a rigid body (3).

Professor B. O. Peirce: Mathematical theory of electricity and magnetism (3).

Mr. Whittemore: Hydrostatics and hydrokinematics (3).

Johns Hopkins.

Professor Morley: Kinematics (1).

Pennsylvania.

Professor Goodspeed: Theory of the potential (1); Analytic statics (1); Rigid dynamics (2); Thermodynamics (1); Dynamics of a particle (1).

Dr. Richards: Application of harmonic series to physical problems.

Yale.

Professor Clark: Electricity and magnetism (1); Thermodynamics and properties of matter (2).

Professor Beebe: Celestial mechanics (3).

Professor Bumstead: Problems in mathematical physics (2).

Mr. Wilson: Analytical mechanics (1½).

MINERALOGY.

Chicago.

Professor Iddings: Advanced petrology (4 or 8); Special petrology (4 or 8).

Columbia.

Professor Moses: Descriptive and determinative mineralogy (2 + *3*); Physical crystallography (1 + *4*); Physical crystallography, advanced (6); Mineralogy, special (research).

Dr. Luquer: The minerals of building-stones (2); Optical mineralogy (2 + *3*, 2 mos.); Optical mineralogy, advanced (12).

Cornell.

Professor Gill: Physical crystallography ($1\frac{1}{2}$); Petrography ($1\frac{1}{2}$); Seminar (1); Research work in mineralogy and petrography.

Harvard.

Professor Wolff: Petrography (3).
Professor Wolff and Dr. Palache: Physical crystallography; Mineralogical and petrographical research.
Dr. Palache: Crystallography.

Johns Hopkins.

Professor Mathews: General mineralogy (4); Advanced mineralogy (3); Petrography (3).

Pennsylvania.

Professor Brown: Mathematical and physical crystallography ($1+4$); Systematic mineralogy ($1+4$); Chemical and synthetic mineralogy ($1+3$); Determination of minerals (*4*).

Yale.

Professor Penfield: Determinative mineralogy (3); Crystallography (1); Descriptive mineralogy ($1\frac{1}{2}$); Descriptive mineralogy, advanced (1); Experimental work in crystallography and mineralogy; Research courses.

PHYSICS.

(Consult also Mechanics.)

Chicago.

Professor Michelson: Theoretical physics (4, $1\frac{1}{2}$ qr.); Experimental physics, advanced (*10*); Research course (*20*); Spectrum analysis (4, 6 wks.); Interference methods and their application (4, 6 wks.).
Dr. Mann: Development of physical ideas (4, 1 qr.).

Columbia.

Professor Rood: Magnetism and electricity, sound ($2+2$ or *6*); Light, heat ($3+2$ or *4*).
Professor Hallock: Units and measurements, exact electrical measurement ($2+2$ to *8*).
Professors Rood, Hallock, Dr. Tufts, Mr. Trowbridge: Laboratory courses in physics.

Cornell.

Professor Nichols: Physical seminar (2).
Professor Merritt: Theoretical physics (4); Recent advances in experimental physics (1).
Professors Nichols and Merritt: Advanced laboratory practice in general physics (research).
Professor Moler: Advanced photography (2).
Mr. Shearer: Theory of light (4); Wave motion (2).
Mr. Ambler: Theory of alternating currents (1).

Harvard.

Professor B. O. Peirce: Electrostatics, electrokinematics, electromagnetism (1, *6* to *8*); Electricity and magnetism (research).
Professor Hall: Heat and electricity (research).
Professor Trowbridge: Electrodynamics (*9*); Light and electricity (research).
Professors Trowbridge and Sabine: Electrodynamics, magnetism, electromagnetism ($2+$ lab.).
Professor Sabine: The theory of the microscope ($1\frac{1}{2}$); Light and heat ($2+6$ to *8*); Research courses in light and heat.

Johns Hopkins.

Professor Ames: General physics (3).
Professor Wood: Physical optics ($1\frac{1}{2}$); Recent progress in physics (3).
Mr. Whitehead: Applied electricity.

Pennsylvania.

Professor Goodspeed (see Mechanics).
Professor Goodspeed and Dr. Richards: Absolute physical measurements (*3* to *9*); Theory and practice of spectroscopy (*3*); Seminary (1).
Dr. Richards: Electricity and magnetism (2); Theory of sound (1); Radiation, electromagnetic theory (2).

Yale.

Professor A. W. Wright: Physics [heat, light, electricity, magnetism] (2); Advanced physics (2).
Professor Hastings: Theory of observation, method of least squares, theory of electricity, electrical measurements ($3+6$).

PHYSIOLOGICAL CHEMISTRY.

Chicago.

Professor Mathews: Physiological chemistry (*4* or *6*, *1 qr.*).

Columbia.

Professor Chittenden, Dr. Gies, Messrs. Richards and Cutter: General physiological chemistry ($2+6$).
Dr. Gies, Mr. Cutter: Advanced physiological chemistry, laboratory (*6*).
Dr. Gies, Mr. Richards: Special physiological chemistry, laboratory (*12*).

Cornell.

Professor Orndorff, Mr. Teeple: Physiological chemistry ($2+2$).
Professor Orndorff: Advanced physiological chemistry (laboratory).

Harvard.

Dr. Koch: Chemical physiology ($1\frac{1}{2}$).

Yale.

Professor Chittenden: Physiological chemistry (*2*).
Professors Chittenden and Mendel: Physiological chemistry ($4+4$).

PHYSIOLOGY.

Chicago.

Professor Loeb: The physiological effects of ions (4, 1 qr.); Physiology of space sensations (4, 1 qr.); Physiological morphology and theory of tropisms (4, 1 qr.); Seminar (1); Research work (8).

Columbia.

Professor Curtis: Laboratory course in special physiology (*3*).
Professors Curtis, Lee, Dr. Green; The physiology of man as related to that of other mammals and of lower vertebrates (4).
Professor Lee: General physiology (1).
Professor Lee, Mr. Budington: Laboratory course in general physiology (*5*).

Cornell.

Professor Wilder, Dr. Stroud, Mr. Reed: Research in physiology (daily); Fortnightly conference.

Harvard.

Professor Bowditch: Experimental physiology (research).

Johns Hopkins.

Professor Howell: Research courses; Physiological journal club (1); Physiological seminar (1).

Professor Howell, Drs. Dawson, Erlanger, Mr. Stiles: Advanced research; Regular medical course ($1\frac{1}{2} + 3$); Special course (3).

Yale.

Professor Chittenden: Elementary physiology (1); Experimental toxicology (1); Physiology of nutrition (1).

Professors Chittenden, Mendel: Experimental physiology (3); Seminary (2).

PSYCHOLOGY.

Chicago.

Professor Dewey: Seminar, mental development (4, 2 qr.).

Professor Angell, Dr. Fite: Experimental psychology, training course (4, 3 qr.); Experimental psychology, research (4, 3 qr.).

(See also Sociology and Statistics.)

Columbia.

Professor Cattell: Experimental psychology, introductory (2); Problems in experimental psychology (2); Research in experimental psychology (daily).

Professor Cattell, Mr. Davis: Experimental psychology, laboratory (*2* or *4*).

Professor Starr: Diseases of the mind and nervous system (1).

Professor Farrand: Physiological psychology (3); Abnormal and pathological psychology (1); Research in physiological and abnormal psychology.

Professor Thorndike: Genetic psychology, advanced (2); Research in genetic and comparative psychology.

Mr. Strong: Analytic psychology (1); Philosophy of mind (1); Research in analytic psychology and the philosophy of mind.

Cornell.

Professor Titchener, Drs. Bentley, Whipple, Mr. Baird: Systematic psychology (3); Laboratory exercises in psychology; Seminar in psychology, and advanced laboratory work.

Dr. Bentley: History of psychophysics ($\frac{1}{2}$).

Dr. Washburn: Social psychology.

Harvard.

Professor James: The psychological elements of religious life ($\frac{1}{2}$).

Professor Münsterberg: Psychological seminar, The theory of the will (2).

Professor Münsterberg, Dr. MacDougall: Experimental psychology, advanced research.

Dr. MacDougall: Advanced psychology ($1\frac{1}{2}$); Experimental psychology, elementary (*5*).

Pennsylvania.

Professor Witmer: Fundamental processes (1); Physiological psychology (1); Complex mental processes (1); Experimental psychology (1); Modern psychological theory ($1\frac{1}{2}$); Seminar in child psychology ($1\frac{1}{2}$); Research.

Yale.

Professor Duncan: General psychology, advanced (2).

Professor Scripture: Physiological and experimental psychology (2); Experimental psychology, elementary (2); Experimental phonetics (1); Theory of statistics and measurements (1); Technical course in experimental psychology (1); Research.

SOCIOLOGY AND STATISTICS.

Chicago.

Professor Small: The ethics of sociology (4, 1 qr.); Seminar, Problems in methodology and classification (4); The premises of general sociology (4, 1 qr.); An outline of general sociology (4, 1 qr.).

Professor Henderson: The group of industrials (4, 1 qr.); Seminar, Methods of social amelioration (4); Urban communities (4, 1 qr.); Philanthropy in its historical development (4, 1 qr.).

Professor Talbot: Seminar in sanitary science (4).

Professor Thomas: Art and the artist class (4, 2 qrs.); Development of mind in the race (4, 1 qr.); Primitive social control (4, 1 qr.).

Professor Vincent: Public opinion (4, 1 qr.); Education as a social function (4, 1 qr.).

Dr. Mitchell: Training course in statistics (4, 1 qr.).

Columbia.

Professor Giddings: Principles of sociology (2); Social evolution (1); Progress and democracy (1); Pauperism, poor laws and charities (1); Crime and penology (1); Seminar in sociology (1).

Professor Mayo-Smith: Statistics and sociology (1); Statistics and economics (1); Theory of statistics (1); Laboratory work in statistics.

Dr. Ripley: Racial demography.

Dr. Bayles: The civil aspect of ecclesiastical organizations (1).

Cornell.

Professor Willcox: Elementary social economics (2); Elementary statistics ($2 + 2$); Advanced statistics (2).

Professor Fetter: Methods of modern philanthropy (2).

Professor Powers: The modern régime (2); Social interpretation of art (1); Seminar, The evolution of society (2).

Harvard.

Professor Ashley: Statistics (1).

Professor Carver: Principles of sociology (3); Socialism and communism (1).

——— : Seminar (1).

Johns Hopkins.

Dr. Brackett: Public aid, charity and correction (1, 3 mos.); Conferences on charitable legislation and custom in England and the United States (1).

Pennsylvania.

Professor Lindsay: Structure of modern society (2); Social-debtor classes (2); Seminar in sociology.

Yale.

Professor Sumner: The mental reactions (2); The beginnings of industrial organization (2); The science of society, elementary (2); The science of society, advanced (2).

ZOOLOGY (INCLUDING NEUROLOGY).

Chicago.

Professors Whitman, Lillie, Dr. Child : Zoological problems, research (1 + *18*).

Professor Davenport : Experimental and statistical zoology (8).

Professors Whitman, Davenport, Lillie, Dr. Child : Seminar in zoology (2).

Professor Donaldson : The growth of the brain and its physical characters as related to intelligence (2 + *4*, 1 qr.); Seminar in neurology (2); Research, the study of neurological problems (8).

Professor Donaldson, Dr. Hardesty : The architecture of the central nervous system (2 + *4*, 1 qr.); Gross and microscopic anatomy of the human central nervous system and sense organs (3 + *6*, 1 qr.).

Dr. Hardesty : The architecture of the central nervous system (2 + *10*, 6 wks.); Comparative histology of the central nervous system and sense organs (2 + *9*).

Columbia.

Professor Wilson : Comparative embryology (1 + lab.); Cellular biology (*3*).

Professor Osborn : Mammals, living and fossil (6).

Professors Wilson, Osborn : Comparative zoology, advanced (*10*).

Professor Dean : Classification and comparative anatomy of the vertebrates (1 + *2*); Embryology of fishes (1), Embryology of vertebrates (½ + 1).

Professor Crampton: Experimental embryology (½).

Dr. Calkins : General zoology of invertebrates, advanced (1½ + *3*); The protozoa (½ + *1*); Sanitary biology (1½).

Dr. Strong : Comparative neurology (1 + *4*); The human brain and spinal cord (1 + *4*).

Dr. McGregor : Mammalian dissection.

Professor Osborn, Dr. McGregor : Readings and conferences in Gegenbaur's *Vergleichende Anatomie* (1).

————— : Practical histology ; Practical embryology ; Seminar ; Journal Club.

Cornell.

Professor Wilder, Dr. Stroud, Mr. Read : Research in vertebrate zoology and neurology (daily); Department conference.

Professor Comstock : Research in entomology (daily); Morphology and development of insects (2).

Professor Gage : Research in histology and embryology (*8*); Advanced microscopy (2½); Seminar in microscopy, histology and embryology.

Harvard.

Professor Mark : Anatomy and development of vertebrates and invertebrates (research).

Professor Mark, Dr. Rand : Microscopical anatomy (1½); Embryology of vertebrates (1½).

Professor Jackson : Fossil invertebrates (1½); Fossil invertebrates, special groups (1½).

Professor Parker : Introduction to the study of the nervous system (1½); The nervous system and its terminal organs (1½).

Dr. Rand, Mr. Carpenter : Comparative anatomy of vertebrates (3).

Dr. Castle : Experimental morphology, phylogenesis (2).

Johns Hopkins.

Professor Brooks, Drs. Andrews, Johnson : Advanced laboratory work (daily); Journal club (1); Seminar (1).

Pennsylvania.

Professor Jayne : Human anatomy (research); Mammalian osteology (research).

Professors Conklin, Montgomery, Dr. Calvert : Comparative anatomy and embryology of the invertebrata (1 + *5*); Zoological seminar (1).

Dr. Moore : Recent and fossil vertebrata (2 + *2*).

Yale.

Professor Verrill : Zoology, comparative anatomy, morphology, histology, systematic zoology.

Professor Smith, Dr. Coe : Elementary anatomy and histology (2); Comparative anatomy and general biology (3); Advanced comparative anatomy and general biology (daily).

Professor Ferris : Comparative morphology of the vertebrate brain (1).

Dr. Coe : Cytology and general embryology (2).

Geo. B. Germann.

PRIZE-SUBJECTS IN APPLIED SCIENCE.*

The program of subjects for which prizes will be awarded by the Société industrielle de Mulhouse next year has been issued, and copies can be obtained upon application to the secretary of the Society. In general chemistry, medals will be awarded for the best memoirs or works on the theory of the manufacture of alizarin reds; the synthesis of the coloring matters of cochineal; theoretical and practical study of the carmine of cochineal; study of the coloring matter of cotton; the composition of aniline blacks; physical and chemical modifications which occur when cotton fiber is transformed into oxycellulose; action of chlorine and its oxygen compounds upon wool; constitution of coloring matters employed in linen fabrics; synthesis of a natural coloring matter used in industries; and theory of the natural formation of an organic substance and preparation of the substance by synthesis.

In connection with dyeing, medals will be awarded for the best works presented on the following subjects: A new mordant which admits of practical use; metallic solutions which give up their bases to textile fibers, and the conditions in which they are most effective; iron mordants and the part they play in dyeing according to their condition of oxidation and hydration; an aniline black which will not de-

* From *Nature*.

teriorate in the presence of other colors or affect these colors, especially those of albumin; a soluble black for dyeing, which will resist the action of light and soap as much as aniline black; a light blue cheap enough to be used to dye wools and not affected by boiling or by light; a blue similar to ultramarine which can be fixed upon cotton by a chemical process; a pure yellow which behaves like alizarin as regards its dyeing properties; a lake-red; a purple; a coloring matter to supersede logwood in its various applications; an assistant especially applicable to wool, capable of being cleared by simple washing, and composed of substances other than tin salts, hydrosulphites, sulphites, and bisulphites; new method of fixing aniline colors; a means of making colors resist the action of soap or of prolonged boiling; a means of producing the sheen of gold and silver upon materials by metallic powders; a manual containing tables showing the densities of as many inorganic and organic compounds as possible, in the crystallized state and in cold saturated solution; the synthesis of a substance having the essential properties of Senegal gum; a substance to supersede egg-white in the dyeing of linen; a colorless blood albumin which can be used instead of egg-white; a manual on the analysis of compounds employed in fabric printing and in dyeing; an indelible ink for marking cotton and similar materials; a practical method of removing grease spots from materials; a memoir on the use of resins in bleaching cotton fiber; a memoir on the bleaching and dyeing of various kinds of cotton; also memoirs dealing similarly with wool and silk; use of hydrogen peroxide for bleaching; improvements in the bleaching of wool and silk; and manuals on the bleaching of cotton, wool, silk, hemp and other fibers.

In connection with fabric printing, medals are offered for an alloy or other substance which has both the elasticity and durability of steel and also the property of not causing any chemical action in the presence of acid colors and colors containing certain metallic salts; a new cylinder machine capable of printing at least eight colors at once; and an application of electricity to bleaching, dyeing or fabric printing.

Among the prize subjects in mechanical arts are: A means of recording by a graphical method the work done by steam engines in a given period (ordinary indicator diagrams do not fulfil the conditions); memoir on the spinning of combed wool; on the force required to start spinning machines; a motor for driving machines used in printing fabrics.

In electricity medals will be awarded for an electric motor the power and driving rate of which can be easily varied; a memoir on the comparative cost of electricity and gas for lighting a town having a population of at least 30,000; and comparative costs of electricity, gas, acetylene and water-gas for lighting an industrial establishment.

Money prizes as well as medals are awarded for some of the subjects, and all the competitions are open to every one, irrespective of nationality. The memoirs, designs or models submitted for the awards should be sent to the president of the Société industrielle de Mulhouse before February 15, 1902.

SCIENTIFIC NOTES AND NEWS.

A ROYAL commission has been appointed in Great Britain to study the relation of bovine and human tuberculosis, consisting of Sir Michael Foster, Dr. Sims Woodhead, Dr. Harris Cox Martin, Professor J. McFadyean and Professor R. W. Boyce.

DR. W J MCGEE and Dr. W. H. Holmes were at St. Louis recently to advise in regard to the exhibit of anthropology and ethnology at the exposition in 1903. Very comprehensive exhibits were recommended, of which we hope to give later a detailed account.

PROFESSOR WILLIS L. MOORE, chief of the Weather Bureau, visited the Yellowstone Park last week, with a view to studying the desirability of establishing there a weather station.

MR. H. D. HUBBARD, private secretary to President Harper, of the University of Chicago, has been appointed, as the result of a civil service examination, secretary of the National Bureau of Standards, at a salary of $2,000 a year.

THE Dutch Academy of Sciences at Harlem has elected to membership H. Haga, professor

of physics at Gröningen; Ed. Verschaffelt, professor of botany and pharmacognosy at Amsterdam, and S. G. De Vries, of Leiden. Foreign members have been elected as follows: H. Becquerel, professor of physics at the École Polytechnique, Paris; Max Planck, professor of mathematical physics and director of the Institute for Theoretical Physics at the University of Berlin, and Heinrich Dubois, associate professor of physics at the same university.

Joseph Y. Bergen, the author of well-known text-books on botany, has resigned his position in the English High School of Boston. With his family he sailed on September 3 for Naples, Italy, where for the future he will make his home.

The officers of the Society for the Promotion of Agricultural Science elected at the recent Denver meeting, to serve for next year, are:

President, W. H. Jordon, director of the New York State Experiment Station, Geneva.

Secretary-Treasurer, F. M. Webster, Wooster Ohio.

Members of the Executive Committee, to serve with the president and secretary, W. J. Beal, Agricultural College, Mich.; W. R. Lazenby, Columbus, Ohio; C. S. Plumb, Lafayette, Indiana.

Dr. Adolf Fick, the eminent physiologist, died on August 21, at the age of seventy-one years. He was born at Cassell, and after studying at Zurich became professor at that University in 1876. In 1868 he removed to Würzburg, where he made the laboratory of physiology one of the most important in Germany. He published a well known compendium of physiology, the third edition of which appeared in 1882, and was also the author of books on the physiology of the senses and on muscular contraction, to which subjects his researches contributed in an important degree.

The death is announced of Admiral Jonquières, the well-known French geometer.

Professor Samuel Porter, a widely known teacher of the deaf and dumb, died at his home in Farmington, Conn., on September 2, at the age of ninety-one. He was a son of President Noah Porter, of Yale College, and graduated from that institution. He began the instruction of the deaf and dumb at Hartford, where he remained till 1836. In 1846 he went to New York and in 1866 was made professor of mental science and English philology at Gallaudet College, Washington. He became professor emeritus in 1884.

During the present season the biological laboratory of the United States Fish Commission at Wood's Holl, Massachusetts, has been under the personal direction of Dr. H. M. Smith, of the Commission staff. The former director, Dr. H. C. Bumpus, owing to his new duties at the American Museum of Natural History, was unable to continue his services, much to the regret of Commissioner Bowers. Among those who have occupied tables and pursued investigations during the summer are Dr. Robert P. Bigelow, Massachusetts Institute of Technology; Dr. Gary N. Calkins, Columbia University; Dr. Otto Folin, McLean Hospital (Waverly, Mass.); Dr. Caswell Grave, Johns Hopkins University; Mr. Karl Kellerman, U. S. Department of Agriculture; Dr. F. T. Lewis, Harvard Medical School; Dr. H. R. Linville, DeWitt Clinton High School; Professor W. J. Moenkhaus, Indiana University; Professor George H. Parker, Harvard University; Dr. H. W. Rand, Harvard University; Dr. R. M. Strong, Harvard University; Dr. F. B. Sumner, College of the City of New York; Dr. W. T. Swingle, U. S. Department of Agriculture, and Professor R. W. Tower, Brown University.

Two vacancies in the position of assistant computer in the Nautical Almanac Office will be filled by civil service examination on October 8 and 9.

A New York State civil service examination will be held on or about September 28, to fill certain positions, including that of electrical engineer, at a salary of $900, and of instructor in various manual arts in the State reformatories and institutions.

At the approaching annual reception and opening of the American Museum of Natural History, New York, the Tiffany collection of gems, recently presented to the museum by Mr. J. Pierpont Morgan, will be on exhibition; part of the Bement collection of minerals will also be exhibited.

THE library of natural history, which the Park Department has fitted up in the Swedish schoolhouse on the West Drive near the Metropolitan Museum, is used by fifty to one hundred people daily. It will be kept open during the winter, and it is expected that it will be used by children from the schools. The library is dependent on gifts, and books or journals bearing on natural history will be gladly received.

MR. ANDREW CARNEGIE has offered $20,000 and $15,000, respectively, to Riverside, Cal., and Chatham, N. Y., for public libraries.

THE New York City Board of Health has adopted resolutions requiring public institutions to report cases of malaria and requesting physicians to do the same.

IN harmony with the vote of the executive committee, the eighteenth annual meeting of the Association of Official Agricultural Chemists will be held in Washington, D. C., beginning Thursday, November 14, and continuing over Friday and Saturday, 15 and 16, or until the business of the Association is completed. The authorities of the Columbian University have extended the courtesy of the use of the University lecture hall for the various sessions. The following order of business will be observed: The president's address; reports of the referees on nitrogen, on potash, on phosphoric acid, on soils, on ash, on foods and feeding stuffs, on liquor and food adulteration, on dairy products, on sugar, on tannin, on insecticides; reports of special committees (abstract committee, food standards, fertilizer legislation, volumetric standards).

THE following preliminary program of subjects for the proposed International Conference on Plant Breeding and Hybridization, to be held in the fall of 1902, is announced by the Horticultural Society of New York. The exact dates for the meetings are not yet decided upon, and the program as given is subject to alteration:

Results of Hybridization and Plant Breeding in Canada. (Illustrated by specimens.) William Saunders, director of the Central Experimental Farm, Ottawa, Canada.

Notes on Plant Breeding in California. E. J. Wickson, horticulturist, Agricultural Experiment Station, University of California.

Plant Breeding in New Jersey. (Illustrated by specimens.) B. D. Halsted, professor of botany in Rutgers College, New Brunswick, N. J.

Hybrid Plums. F. A. Waugh, horticulturist, Vermont Agricultural Experiment Station.

Variations in Hybrids not appearing in the First Generation, but Later. E. S. Goff, horticulturist, Agricultural Experiment Station, University of Wisconsin.

Results in the breeding of Species of Ricinus. E. Mead Milcox, botanist, Oklahoma Agricultural Experiment Station.

On Orchid Hybrids. (Illustrated by specimens of the parents and progeny.) Oakes Ames, Ames Botanical Laboratory, North Easton, Mass.

The Wild Hybrids of the North American Flora. (Illustrated by specimens of the parents and progeny.) David George, museum aid, New York Botanical Garden.

Hybrid Beans. R. A. Emerson, horticulturist, Agricultural Experiment Station, University of Nebraska.

Cytological Aspects of Hybrids. W. A. Cannon, Columbia University, New York City.

Correlation between the Fruit and other Parts of the Plant in Form, Color and other Characteristics. (Illustrated by specimens.) S. A. Beach, horticulturist, New York State Experiment Station, Geneva, N. Y.

Other papers, the titles of which have not yet been communicated, are also promised from the following: Delegates representing the Royal Horticultural Society of England; Luther Burbank, Santa Rosa, Cal.; J. Craig, Cornell University, Ithaca, N. Y.; K. C. Davis, West Virginia Agricultural Experiment Station; S. B. Green, Agricultural Experiment Station, University of Minnesota; H. C. Price, Iowa Agricultural Experiment Station; W. van Fleet, M.D., Little Silver, N. J.; J. C. Whitten, Agricultural Experiment Station, Columbia, Mo.; C. W. Ward, Queens, N. Y.; H. J. Webber and others representing the United States Department of Agriculture.

THERE was held at Glasgow last week an international engineering congress under the auspices of the leading British engineering societies. Lord Kelvin was the honorary president and Mr. James Mansergh the president. The sections in which the congress met were as follows:

Section I.—Railways. Chairman, Sir Benjamin Baker.

Section II.—Waterways and Maritime Works. Chairman, Sir John Wolfe Barry, K.C.B., F.R.S.

Section III.—Mechanical Engineering (Institution of Mechanical Engineers). Chairman, Mr. W. H. Maw.

Section IV.—Naval Architecture and Marine Engineering (Institution of Naval Architects). Chairman, the Right Hon. the Earl of Glasgow.

Section V.—Iron and Steel (Iron and Steel Institute). Chairman, Mr. William Whitwell.

Section VI.—Mining (Institution of Mining Engineers). Chairman, Mr. James S. Dixon.

Section VII.—Municipal Engineering (Association of Municipal and County Engineers). Chairman, Mr. E. George Mawbey.

Section VIII.—Gas Engineering (Institution of Gas Engineers). Chairman, Mr. George Livesey.

Section IX.—Electrical (Institution of Electrical Engineers). Chairman, Mr. W. E. Langdon.

THE Department of State has received from the Russian Embassy, Washington, under date of August 12, 1901, notice of the International Exposition and Congress of Fisheries, to be held in St. Petersburg in 1902. An invitation is extended to the United States to participate in the exposition and to send official delegates and experts to the congress. The exhibition is open to Russian and foreign exhibitors. Its objects consist in: (*a*) Determining the actual condition of sea and fresh-water fisheries, and of other similar pursuits; (*b*) acquainting producers and consumers with the various products of fisheries and with methods of preparing and preserving the same; (*c*) exhibiting the gradual development and actual state of artificial fish breeding, as likewise the various aspects of amateur fishing and angling; (*d*) promoting scientific research pursued in the interests of fisheries.

DR. CALMETTE, the director of the Pasteur Institute at Lille, and the discoverer of a curative serum for the effect of snake-bite, was, as a correspondent to the *Lancet* reports, recently severely bitten on the hand by a trigonocephalus. Dr. Calmette without delay gave himself an injection of his anti-venomous serum, but nevertheless the hand swelled up and acute fever set in; but by the afternoon of the same day Dr. Calmette was sufficiently recovered to attend a sitting of the Conseil-Général of the Department, at which he argued in favor of a grant in aid of the sanatorium which he has undertaken to found at Lille. On the following day he was perfectly well, having thus afforded in his own person, albeit unwillingly, a convincing proof of the efficacy of his excellent remedy.

UNIVERSITY AND EDUCATIONAL NEWS.

IT appears that German soldiers are still occupying the buildings of the University at Tien-Tsin, and the question has been brought to the attention of our Department of State, the institution being conducted under American auspices.

THOMAS L. WATSON, Ph.D. (Cornell), assistant state geologist of Georgia for the past four years, has been elected professor of geology and botany at Denison University, Granville, Ohio.

PROFESSOR F. C. VAN DYCK, who holds the chair of electricity and mechanics at Rutgers College, has been made dean of the faculty.

E. B. HOLT, M.A. (Columbia), Ph.D. (Harvard), has been appointed instructor in psychology in Harvard University, succeeding Dr. Robert MacDougall, recently called to the chair of psychology in the School of Pedagogy, New York University.

MR. FRANK NICHOLAS SPINDLER has been elected professor of psychology and pedagogy in the State Normal College, at Stevens Point, Wisconsin.

MR. A. H. YODER, of the University of Indiana, has been appointed professor of pedagogy at the University of Washington.

A. L. KROEBER, PH.D. (Columbia), has been appointed instructor in Indian anthropology in the University of California.

AT Brown University, Mr. G. F. Parmenter and Dr. N. A. Dubois have been appointed instructors in chemistry.

MR. S. Y. WARA has been awarded a teaching fellowship in chemistry in the University of Missouri.

DR. RUDOLPH ZUBER has been promoted to a full professorship of geology at the University at Lemberg.

William McKinley, twenty-fifth President of the United States, universally beloved and honored by a Nation whose greatness he maintained and advanced, died on September 14, 1901.